Model 8365 Series
Dual-Technology Visibility Sensor

User's Manual

Rev. D

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Revision History

Revision	Date	Summary of Changes
A	2013 Ju1 1	Initial release.
B	2014 Jul 15	Added 220 V AC lightning protection to Section 4.7.3, clarified standard output data format in Section 7.1.1, added Step 3 to Visibility Sensor calibration instructions in Section 8.1, updated temperature specifications.
C	2015 Feb 12	Updated Visibility Controller enclosure to new enclosure being used.
D	2015 Sept 22	Updated Introduction to remove statement that particles sizes were measured

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1. INTRODUCTION

The 8365 Dual Technology Visibility Sensor measures the transparency of the atmosphere and calculates its extension coefficient and meteorological optical range (MOR) values. The direct-attenuation technologies used by the 8365 provide measurements once available only from a transmissometer, and are now coupled with the reliability and cost-effectiveness of a forward-scatter visibility sensor. This precision makes the 8365 ideal for applications such as aviation and meteorological studies requiring high performance and reliability.

The 8365 Visibility Sensor determines visibility by measuring the optical extinction coefficient of a beam of light as it passes through a known volume of air. Any particles in the air such as fog, rain, or snow will affect the extinction coefficient. This value can then be transmitted to an external computer in its unaltered form or translated into an equivalent MOR value in miles or kilometers.

In AWOS systems, the extinction coefficient value is sent to the Model 1190 Data Collection Platform (DCP), which passes the value along with sensor status information to the AWOS 3000 Central Data Processor (CDP). The CDP then calculates visibility, variable visibility, and RVR (international systems only) values.

When used in AWOS systems, the 8365 sensor does not require the optional Handheld Terminal; all setup, test, and calibration functions are accessible from the AWOS DCP's built-in keypad and display. Other AWOS features include support for a Day/Night sensor and an Ambient Light Sensor (ALS), which is required for RVR applications. For 220VAC applications, a transformer kit is available to allow the sensor (which operates at 110 V, 60 Hz) to operate from a 220 V, 50 Hz AC supply.

The 8365 Visibility Sensor uses a unique two-sensor design that eliminates measurement errors and simplifies calibration. The sensing portion of the sensor (optical emitters and detectors) operates in conjunction with a Visibility Controller Board, which performs control functions for the emitters and detectors, performs built-in test and calibration functions, processes data, and calculates the extinction coefficient product. For applications where an analog output is required, an optional Analog Output module is available.

1.1 8365 MODELS

Two models of the 8365 Visibility Sensor are available. Their form and factor is identical, so they are interchangeable. The only difference between them is the maximum Meteorological Optical Range (MOR).

Visibility Sensor Model Number	MOR
8365-A	33 ft to 20 miles (10 m to 32 km)
8365-C	33 ft to 50 miles (10 m to 80 km)

The Model 8365-A circuit boards use through-hole components, and the Model 8365-C circuit boards use surface-mounted components. Any differences in component labeling or location are identified in this manual based on the specific 8365 model.

1.2 ACCESSORIES

The following accessories and replacement parts are available for the Model 8365 Visibility Sensor.

Part Number	Description
M403326-00	Day/Night Sensor Kit
M488171-01	Ambient Light Sensor Kit
M488317-00	2½" Galvanized Mounting Pipe
M442046	2 A Fuse (F1)
M442057	0.5 A Fuse (F2)
M442048	4 A Fuse (F3)
M488150	Grounding Kit
M488174	220 V AC Kit
M488181	Heater Kit
11903	Backup Battery Kit
M104744	Calibration Paddle
M403321	Handheld Terminal

2. THEORY OF OPERATION

2.1 GENERAL

The 8365 Visibility Sensor measures atmospheric optical extinction coefficient. An infrared emitting diode illuminates the atmospheric sample volume with amplitude-modulated narrow-band optical radiation centered at a wavelength of 865 nm. Optical energy scattered by interaction with particles in the sample volume is measured at a scatter angle of 35 degrees. This angle is selected because it provides a linear scattered signal amplitude for the particle size distribution of interest (haze, fog, rain, and snow). A solid state silicon photodetector measures optical energy scattered from the sample volume. An optical interference filter allows the photodetector to see only a narrow band of energy centered at the 865 nanometer wavelength of the optical emitter array. Signal conditioning after the photodetector detects only signals which are in phase with, and at the same modulation frequency as, the optical source. This synchronous lock-in detection technique provides an output signal proportional to the scattered optical energy which is unaffected by background light or noise created by optical sources in the field of view of the photodetector.

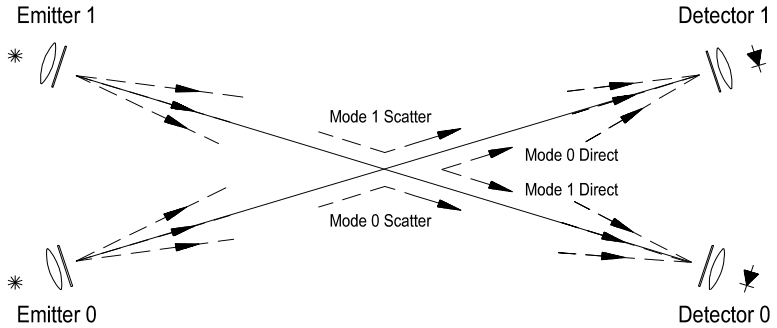


Figure 1. The 8365 Visibility Sensor measures both direct and scattered optical energy, eliminating the need for absolute calibration.

The precise amount of optical energy entering the sample volume must be known if the measured optical extinction coefficient is to be representative of actual visibility. Effects of temperature changes must be compensated for, as must the degradation of optical transmission caused by contaminants on the emitter windows. The impact of these contaminants on optical transmission can be significant. This is true both for long term contaminants such as blowing dust, dirt, or precipitation, and for transient effects such as condensation during fog events.

A similar source for error occurs at the optical detector. Previous forward scatter visibility sensor designs have been based upon performing precise absolute measurements during variable environmental conditions in hostile environments. The All Weather Inc. approach is different. The 8365 Visibility Sensor uses a technique for measuring the optical extinction coefficient that does not depend on absolute calibration of the optical emitter and the optical detector. Two optical emitters are used along with two optical detectors to measure four parameters. Facing emitter/detector pairs measure the direct optical transmission through the sample volume, while the optical energy scattered by haze, fog, rain, or snow is measured by emitter/detector pairs at a 35° angle to one another. Calculations performed using these measured parameters yield an absolute

extinction coefficient value independent of contaminants upon the optical surfaces or the effects of temperature changes on the optical source and measurement electronics.

The Visibility Controller Board contains a microprocessor that performs all the necessary calculations. The Visibility Controller Board output is provided through the serial communications port. The output product is programmable for either visibility (in miles or kilometers) or extinction coefficient. In addition, the output includes sensor status information (such as current sensor configuration, output mode, and averaging interval), as well as calibration, maintenance, and built-in test status. The Visibility Controller Board can be configured for timed output or for operation in an interrogated mode. The averaging interval is programmable for running averages calculated over a period of from 3 minutes to 10 minutes.

User programming is performed in a menu-driven format via a portable Display Terminal (DT) or the AWOS DCP's built-in keypad and display.

Calibration of the sensor is performed by inserting an optical scattering device into the sample volume (see Chapter 4). This calibration is traceable to Air Force Geophysical Laboratory reference transmissometers.

AWOS installations require a Day/Night sensor and a rain gauge. These sensors assist the AWOS Central Data Processor (CDP) in implementing the FAA visibility algorithm. AWOS installations that calculate runway visual range (RVR) require an Ambient Light Sensor (in place of a Day/Night sensor) and a runway light setting interface.

2.2 FUNCTIONAL DESCRIPTION

2.2.1 Visibility Sensor

Two infrared optical emitter assemblies and two optical detector assemblies operate under the control of the Visibility Controller Board. Mode selection, data collection, algorithm processing, heater control, self-test, and communications tasks are handled by the Visibility Controller Board.

Figure 2 shows a diagram of the optical emitter assembly. Power and control logic are provided by the Visibility Controller Board. Power is conditioned in the emitter assembly housing for use by the emitter electronics. The control logic programs a constant current source which drives a single infrared emitting diode. The emitter diode is amplitude modulated at 1024 Hz with a 50% duty cycle. This provides synchronization logic for the optical detectors. Heater power is provided by the Visibility Controller Board. Temperature information gathered by a solid-state temperature sensor is sent from the emitter assembly housing to the Visibility Controller Board.

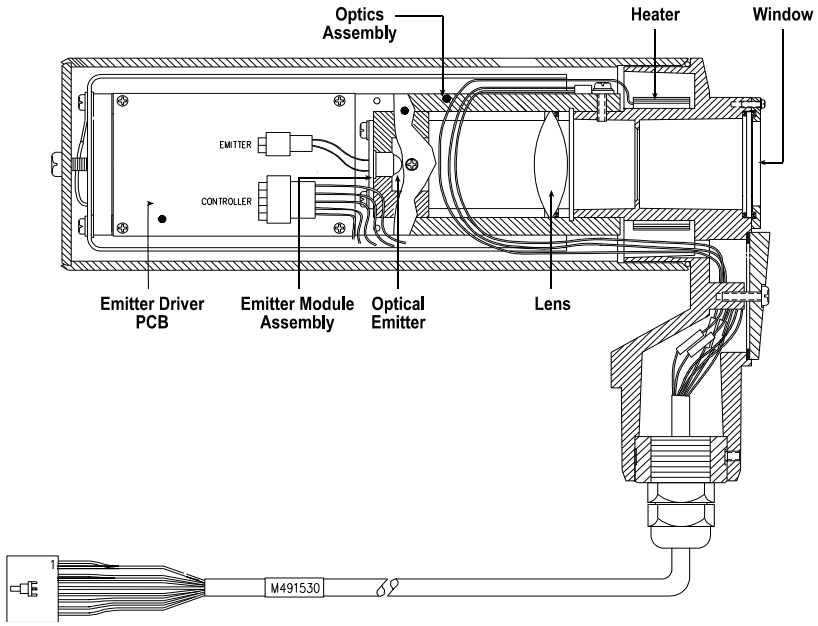


Figure 2. Optical Emitter Assembly

Figure 3 shows a diagram of the optical detector assembly. Power and control logic are provided by the Visibility Controller Board. Power is conditioned in the detector assembly housing for use by the detector electronics. Optical radiation from the sample volume enters through a 1-3/8 inch (35 mm) aperture. The field of view has a ½ angle of 3 degrees. Optical radiation is focused by a quartz lens through an optical bandpass filter, then through a limiting aperture and onto a 0.0084 square inch (5.4 mm^2) silicon photodetector.

The optical bandpass filter allows only a narrow wavelength range to pass through to the detector. The wavelength range is centered at the emission wavelength of the optical emitter. The filter, aperture, and silicon photodetector are parts of an integrated filter/aperture/detector/preamplifier package. This hermetically-sealed package features very high sensitivity, low noise, and excellent linearity over a wide dynamic range. The photodetector/preamplifier output goes to an active electronic bandpass filter having a center frequency tuned to the modulation frequency of the optical emitters. A high-gain amplifier locked to the photodetector/preamplifier is used to amplify the scattered signal.

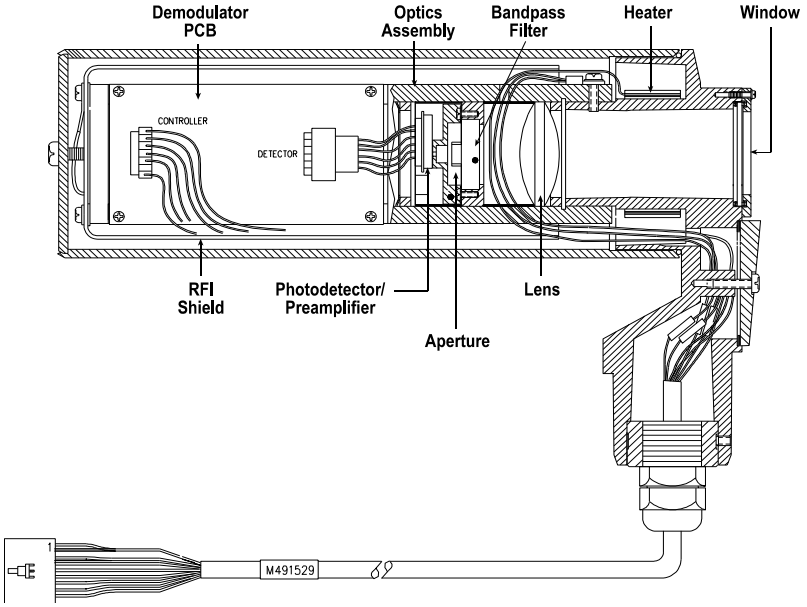


Figure 3. Optical Detector Assembly

The demodulator circuit is referenced to the emitter modulation frequency, and acts as a full-wave rectifier for signals that are in phase with, and at the same frequency as, the modulation reference. The demodulated signal is then filtered. The filtered output is a DC voltage proportional to the component of the incoming optical energy, and this is converted into a digital format by the voltage-to-frequency converter. The resultant frequency is output by the detector assembly for processing by the Visibility Controller Board. The frequency format prevents noise in the interconnecting cable between the detector assembly and Visibility Controller Board from contaminating analog signals.

The detector assembly optical sensitivity is digitally programmed by the Visibility Controller Board. Programmable gains are switched at the photodetector/preamplifier and high-gain amplifier. Three gain settings are used to cover the detector dynamic range. One gain setting is used for the direct transmission mode measurement, while the other two cover the scattering mode range requirements.

2.2.2 Visibility Controller Assembly

The emitter and detector assemblies are controlled by the Visibility Controller Board, which generates the reference frequency for emitter modulation and detector demodulation, sets all emitter and detector modes of operation, measures the detector assembly frequency output, and processes the extinction coefficient algorithm.

The heater controller measures temperature within each emitter and detector enclosure. Solid-state temperature sensors inside each housing provide an analog voltage proportional to the enclosure temperature. The temperature controller monitors these signals, turning 50 W heater elements on and off with a solid-state switch.

2.2.3 Time Constant

The sensor's time constant is a function of the averaging interval selected. For a step change in extinction coefficient, the sensor output data will cross 1/e of the final value in the times listed below.

Averaging Interval	*Time Constant*
3 minutes	1½ minutes — (standard for AWOS)
5 minutes	2 minutes — (optional)
10 minutes	3½ minutes — (optional)

2.2.4 Background Sensitivity

The visibility sensor is unaffected by normal ambient or background optical radiation. The lock-in detection technique previously described averages to zero any signal not in phase with, and at the same frequency as, the emitter modulation frequency.

2.2.5 Measurement Mode

During normal operation, the visibility sensor will operate in the measurement mode. While in the measurement mode, the sensor alternates between Mode 0 and Mode 1 operation with a period of 15 seconds. Each half cycle, a new pair of detector measurements is acquired (one direct and one scatter). Each new pair of measurements is checked for integrity. The measurement cycle period is 1 minute long, with 30 seconds spent in each mode. At the end of each 30 second measurement cycle, a new pair of measured values is available for update of the extinction coefficient product. Should the data be missing for some reason, the measured value will be indicated as MM.MMM.

2.2.6 Three-Headed Operation

A special mode of operation has been incorporated into the design of the 8365 Visibility Sensor to allow it to continue operating even after one of the sensor heads has failed. Three-headed operation is initiated automatically when the software determines that one of the sensor heads (emitter or detector) is not functioning properly. In this mode, special algorithms are used to determine visibility based on the outputs of the three operational heads.

The three-headed mode is intended as an interim measure to provide visibility data until the system can be repaired. The accuracy of a fully functioning system is impossible to maintain when all four heads are not providing data, and the data generated in three-headed mode should be considered an approximation and the sensor should be repaired as soon as possible. In some cases the problem is transitory, and the system will return to full operation on its own. Monitoring the system's two status words will provide valuable troubleshooting information, including the identity of the head that has failed. Section 7.2.1 and Table 5, Table 6, and Table 7 explain the meanings of the status words.

3. VISIBILITY AND RVR

The 8365 Visibility Sensor can be used to determine Runway Visual Range (RVR) in aviation applications with the addition of an Ambient Light Sensor (M) and a Runway Lights Setting Interface. This chapter explains the principle and measurement of visibility and RVR in detail, along with the specific methods used with the 8365.

3.1 DEFINITIONS

Visibility was first defined for meteorological purposes as a quantity to be estimated by a human observer, and observations made in that way are widely used. However, the estimation of visibility is affected by many subjective and physical factors. The essential meteorological quantity, which is the transparency of the atmosphere, can be measured objectively, and is represented by the meteorological optical range (MOR).

The *meteorological optical range* is the length of path in the atmosphere required to reduce the luminous flux in a collimated beam from an incandescent lamp, at a color temperature of 2700 K, to 5% of its original value, the luminous flux being evaluated by means of the photometric luminosity function of the International Commission on Illumination (ICI).

Meteorological visibility by day is defined as the greatest distance at which a black object of suitable dimensions, located near the ground, can be seen and recognized when observed against a scattering background of fog, sky, etc. It should be emphasized that the criterion for recognizing an object, and not merely for seeing the object without recognizing what it is, should be used.

Meteorological visibility at night is defined as:

(a) The greatest distance at which a black object of suitable dimensions could be seen and recognized, if the general illumination were raised to the normal daylight level; or

(b) The greatest distance at which lights of moderate intensity can be seen and identified.

Airlight is light from the Sun and the sky which is scattered into the eyes of an observer by atmospheric suspensoids (and, to a slight extent, by air molecules) lying in the observer's cone of vision. That is, airlight reaches the eye in the same manner as diffuse sky radiation reaches the Earth's surface. Airlight is the fundamental factor limiting the daytime horizontal visibility for black objects because its contributions, integrated along the cone of vision from eye to object, raise the apparent luminance of a sufficiently remote black object to a level which is indistinguishable from that of the background sky. Contrary to subjective estimate, most of the airlight entering an observer's eye originates in portions of his cone of vision lying rather close to him.

The following four photometric qualities are defined in detail in various standards, such as the International Electrotechnical Commission (IEC, 1987):

(a) *Luminous flux* (symbol: *F (or F)*, unit: lumen) is a quantity derived from radiant flux by evaluating the radiation according to its action upon the ICI standard photometric observer;

(b) *Luminous intensity* (symbol: *I*, unit: candela or lm/sr) is luminous flux per unit solid angle;

(c) *Luminance* (symbol: L, unit: cd/m^2) is luminous intensity per unit area;

(d) *Illuminance* (symbol: E, unit: lux or lm/m^2) is luminous flux per unit area.

The *extinction coefficient* (symbol σ) is the proportion of luminous flux lost by a collimated beam, emitted by an incandescent source at a color temperature of 2700 K, while traveling the length of a unit distance in the atmosphere. The coefficient is a measure of the attenuation due to both absorption and scattering.

The *luminance contrast* (symbol C) is the ratio of the difference between the luminance of an object and its background and the luminance of the background.

The *contrast threshold* (symbol ε) is the minimum value of the luminance contrast that the human eye can detect, i.e., the value that allows an object to be distinguished from its background. The contrast threshold varies with the individual.

The *illuminance threshold (E_t) is* the smallest illuminance, at the eye, for the detection of point sources of light against a background of specified luminance. The value of E_t, therefore, varies according to lighting conditions.

The *transmission factor* (symbol T) is defined, for a collimated beam from an incandescent source at a color temperature of 2700 K, as the fraction of luminous flux which remains in the beam after traversing an optical path of a given length in the atmosphere. The transmission factor is also called the transmission coefficient. The terms transmittance or transmissive power of the atmosphere are also used when the path is defined, i.e., of a specific length (e.g., in the case of a transmissometer). In this case, T is often multiplied by 100 and expressed in percent.

3.2 UNITS AND SCALES

The meteorological visibility or MOR is expressed in meters or kilometers. The measurement range varies according to application. While for synoptic meteorological requirements, the scale of MOR readings extends from below 100 m to more than 70 km, the measurement range may be more restricted for other applications. This is the case for civil aviation where the upper limit may be 10 km. This range may be further reduced when applied to the determination of the runway visual range, which represents landing and takeoff conditions in reduced visibility. Runway visual range is required only between 50 and 1500 meters. For other applications, such as road or sea traffic, different limits may be applied according to both the requirements and the locations where the measurements are made.

The errors of visibility measurements increase in proportion to the visibility, and measurement scales take account of this. This fact is reflected in the code used for synoptic reports by the use of three linear segments with decreasing resolution, i.e., 100 to 5 000 m in steps of 100 m, 6 to 30 km in steps of 1 km, and 35 to 70 km in steps of 5 km. This scale allows visibility to be reported with a better resolution than the accuracy of the measurement, except when visibility is less than about 900 m.

The extinction coefficient may also be reported instead of the visibility. The units for the extinction coefficient may be scaled miles^{-1} or km^{-1}, but only scaled miles^{-1} units are output for the extinction coefficient in the 8365 output data.

3.3 METEOROLOGICAL REQUIREMENTS

The concept of visibility is used extensively in meteorology in two distinct ways. Firstly, it is one of the elements identifying air-mass characteristics, especially for the needs of synoptic meteorology and climatology. Here, visibility must be representative of the optical state of the atmosphere. Secondly, it is an operational variable which corresponds to specific criteria or special applications. For this purpose, it is expressed directly in terms of the distance at which specific markers or lights can be seen. One of the most important special applications is found in meteorological services to aviation.

The measure of visibility used in meteorology should be free from the influence of extra-meteorological conditions, but it must be simply related to intuitive concepts of visibility and to the distance at which common objects can be seen under normal conditions. MOR has been defined to meet these requirements, being convenient for instrumental methods by day and night, and having well-understood relations with other measures of visibility. MOR has been formally adopted by WMO as the measure of visibility for both general and aeronautical uses (WMO, 1990a). It is also recognized by the International Electrotechnical Commission (IEC, 1987) for application in atmospheric optics and visual signaling.

MOR is related to the intuitive concept of visibility through the contrast threshold. In 1924, Koschmieder, followed by Helmholtz, proposed a value of 0.02 for ε. Other values have been proposed by other authors. They vary from 0.0077 to 0.06, or even 0.2. The smaller value yields a larger estimate of the visibility for given atmospheric conditions. For aeronautical requirements, it is accepted that E is higher than 0.02, and it is taken as 0.05 since, for a pilot, the contrast of an object (runway markings) with respect to the surrounding terrain is much lower than that of an object against the horizon. It is assumed that when an observer can just see and recognize a black object against the horizon, the apparent contrast of the object is 0.05. This leads to the choice of 0.05 as the transmission factor adopted in the definition of MOR.

3.4 MEASUREMENT METHODS

Visibility is a complex psychophysical phenomenon, governed mainly by the atmospheric extinction coefficient associated with solid and liquid particles held in suspension in the atmosphere. The extinction is caused primarily by scattering rather than by absorption of the light. Its estimation is subject to variations in individual perception and interpretative ability as well as the light source characteristics and the transmission factor. Thus, any visual estimate of visibility is subjective.

When visibility is estimated by a human observer it depends not only on the photometric and dimensional characteristics of the object which is, or should be, perceived, but also on the observer's contrast threshold. At night, it depends on the intensity of the light sources, the background illuminance and, if estimated by an observer, on the adaptation of the observer's eyes to darkness and the observer's illuminance threshold. The estimation of visibility at night is particularly problematic. The first definition of visibility at night provided at the beginning of this chapter is given in terms of equivalent daytime visibility in order to ensure that no artificial changes occur in estimating the visibility at dawn and at twilight. The second definition has practical applications especially for aeronautical requirements, but it is not the same as the first and usually gives different results. Both are evidently imprecise.

Instrumental methods measure the extinction coefficient from which the MOR may be calculated. The visibility may then be calculated from knowledge of the contrast and illuminance thresholds, or by assigning agreed values to them. However, fixed instruments are used on the assumption that the extinction coefficient is independent of distance. Some instruments measure attenuation directly and others measure scattering of light to derive the extinction coefficient. The brief analysis of the physics of visibility in this chapter may be useful for understanding the relations between the various measures of the extinction coefficient, and for considering the instruments used to measure it.

3.5 BASIC EQUATIONS

The basic equation for visibility measurements is the Bouguer-Lambert law:

$$F = F_0 e^{-\sigma x} \tag{1}$$

where F is the luminous flux received after a length of path x in the atmosphere and F_0 *is* the flux for $x = 0$. Differentiating, we obtain:

$$\sigma = \frac{-dF}{F} \cdot \frac{1}{dx} \tag{2}$$

Note that this law is valid only for monochromatic light, but may be applied to a spectral flux to a good approximation. The transmission factor is:

$$T = \frac{F}{F_0} \tag{3}$$

Mathematical relationships between MOR and the various variables representing the optical state of the atmosphere may be deduced from the Bouguer-Lambert law. From Equations 1 and 3 we may write:

$$T = \frac{F}{F_0} = e^{-\sigma x} \tag{4}$$

If this law is applied to the MOR definition, $T = 0.05$, then $x = P$, and the following may be written:

$$T = 0.05 = e^{-\sigma P} \tag{5}$$

Hence, the mathematical relation of MOR to the extinction coefficient is:

$$P = \left(\frac{1}{\sigma}\right) \cdot \ln\left(\frac{1}{0.05}\right) \approx \frac{3}{\sigma} \tag{6}$$

where ln is the log to base e, or the natural logarithm. When combining Equation 4, after being deduced from the Bouguer-Lambert law, and Equation 6, the following equation is obtained.

$$P = x \cdot \frac{\ln(0.05)}{\ln(T)} \tag{7}$$

This equation is used as a basis for measuring MOR with transmissometers.

3.5.1 Meteorological Visibility in Daylight

The contrast of luminance is:

$$C = \frac{L_b - L_h}{L_h} \quad (8)$$

where L_h is the luminance of the horizon, and L_b is the luminance of the object.

The luminance of the horizon arises from the light scattered from the atmosphere along the observer's line of sight. It should be noted that if the object is darker than the horizon, then C is negative, and that if the object is black (L_b = 0), then C = -1.

In 1924, Koschmieder established a relationship, which later became known as Koschmieder's law, between the apparent contrast (C_x) of an object, seen against the horizon sky by a distant observer, and its inherent contrast (C_o), i.e., the contrast that the object would have against the horizon when seen from very short range. Koschmieder's relationship can be written as:

$$C_x = C_0 e^{-\sigma x} \quad (9)$$

This relationship is valid provided the scatter coefficient is independent of the azimuth angle and there is uniform illumination along the whole path between the observer, the object, and the horizon. If a black object is viewed against the horizon (C_o = -1) and the apparent contrast is -0.05, then Equation 9 reduces to:

$$0.05 = e^{-\sigma x} \quad (10)$$

Comparing this result with Equation 5 shows that when the magnitude of the apparent contrast of a black object seen against the horizon is 0.05, then that object is at MOR (P).

3.5.2 Meteorological Visibility at Night

The distance at which a light (a night visibility marker) can be seen at night is not simply related to MOR. It depends not only on MOR and the intensity of the light, but also on the illuminance at the observer's eye from all other light sources.

In 1876, Allard proposed the law of attenuation of light from a point source of known intensity (I) as a function of distance (x) and extinction coefficient (σ). The illuminance *(E)* of a point light source is given by:

$$E = I \cdot r^{-2} \cdot e^{-\sigma x} \tag{11}$$

When the light is just visible, $E = E_t$, and the following may be written:

$$\sigma = \left(\frac{1}{r}\right) \cdot \ln\left(\frac{I}{E_t \cdot x^2}\right) \tag{12}$$

Noting that $P = (l/a) \bullet \ln(1/0.05)$ in Equation 6, we may write:

$$P = r \cdot \frac{\ln\left(\frac{1}{0.05}\right)}{\ln\left(\frac{I}{E_t \cdot x^2}\right)} \tag{13}$$

3.6 RUNWAY VISUAL RANGE (RVR)

Runway Visual Range (RVR) is used in aviation applications, and is defined as the range over which the pilot of an aircraft on the center line of a runway can see the runway surface markings or the lights delineating the runway or identifying its center line.

The main purpose of RVR is to provide pilots, air traffic services units, and other aeronautical users with information on runway visibility conditions during periods of low visibility, whether due to fog—the most frequent cause of low visibility in many places—or to other causes such as rain, snow, or sand storms. In particular, RVR is required to allow an assessment to be made as to whether conditions are above or below the specified operating minima.

Assessment of RVR is by calculation, based on Koschmieder's law in the case of objects or markings—that is, during daytime—and Allard's law in the case of lights—that is, at night—taking into account the prevailing atmospheric conditions.

As explained earlier, an observer (in this case a pilot in the cockpit) can see and identify objects such as markers, small trees, etc. if the contrast ratio with the sky or fog background is 0.05. The maximum visual range of such objects can be calculated for this contrast ratio if atmospheric transmittance (t) or extinction coefficient (σ) are known. The 8365 determines the extinction coefficient, and uses this value to determine the maximum visual range. This calculated range is usually referred to as the MOR, as explained earlier. However, when the MOR by day exceeds the RVR based on lights, it is usually quoted as the RVR.

RVR based on lights takes into account three factors:

1. The intensity of the runway edge and runway center line lights (I)
2. The optical clarity of the atmosphere, expressed in terms of atmospheric transmittance (t) or extinction coefficient (σ)
3. The visual threshold of illumination (E_t) of the eye that is required for a point source or small light to be visible. This is related to the measured luminance of the background against which the light is viewed

These three factors are evaluated using the 8365 (which calculates the extinction coefficient—optical clarity of the atmosphere), the M488171 Ambient Light Sensor (which measures the background luminance—used to determine the visual threshold of illumination), and the Runway Lights Setting Interface (which communicates the intensity of the runway lights to the RVR software).

3.7 RVR CALCULATION

When using the 8365 to determine RVR, All Weather Inc. RVR software is used in conjunction with the 8365, a Model M488171 Ambient Light Sensor, and a Runway Lights Setting Interface. To perform the runway visual range calculations, the software uses the background luminance, runway light intensity, and extinction coefficient raw data to calculate the values using both Allard's and Koschmieder's laws. It then determines which routine gives the greatest runway visual range and returns that number.

The variables used in determining RVR are defined as follows:

K	the RVR value calculated from Koschmieder's equations
R	the RVR value calculated from Allard's equations
σ	the extinction coefficient for Koschmieder's law in daytime
bgl	background luminance in candelas/m^2
I	light intensity in candle power
E_t	illumination threshold

Calculate the runway light intensity in candle power from light setting interface from the chart describing intensity of the runway lights.

Calculate Koschmieder's law for daylight visibility using the following formula.

$$K = \frac{\ln \cdot 0.05}{\sigma}$$

Calculate Allard's value from the following equations.

$$E_T = 10^{-5.7 + .64 \log(bgl)}$$

$$E_T = \frac{Ie^{-\sigma R}}{R^2}$$

Choose the larger value, i.e., maximum (R, K). This is the RVR.

3.7.1 RVR Reporting Range

RVR values are displayed by an AWOS system. The minimum value reported is 50 m, and the maximum is 2000 m. The display shows M0050 when the RVR value is <50 m, and it shows P2000 when the RVR value is >2000 m.

4. INSTALLATION

The 8365 Visibility Sensor consists of the visibility sensor (two emitters and two detectors), an optional Day/Night sensor or Ambient Light Sensor, and a Visibility Controller Board. This instrument is thoroughly tested and fully calibrated at the factory and is ready for installation. A calibration check should be performed upon completion of the installation (see ***Chapter 8***).

4.1 SENSOR SITING

Locate the sensor as far as practical from strobe lights and other modulated light sources. Do not locate it in an area that is subject to localized obstructions to vision (e.g., smoke, dust, etc.). At the same time, it should not be so isolated that it cannot detect more widespread obstructions when they affect visibility in the area of concern.

Keep the area within 6 ft (2 m) of the sensor free of all vegetation and well drained, and keep any grass or vegetation within 100 ft (30 m) of the sensor clipped to a height of about 10" (25 cm). These precautions are necessary to reduce interference of insects and carbon-based aerosols (e.g., terpenes) with sensor performance.

4.1.1 Multiple Sensor Installations

In installations where multiple visibility sensors are used, it is important to maintain adequate optical isolation between the sensors. Care must be taken to ensure that the optical emitter of one unit is not within the field of view of any others. It is recommended that no sensor be installed within 50 feet of another and that the orientation of adjacent sensors be parallel.

4.2 AWOS SITING

Site AWOS installations according to siting order 6560.20.

4.3 MAST INSTALLATION

(See Figure 4**)** The visibility sensor mounts on a 2.87" (73 mm) O.D. mast. A section of standard 2½" galvanized steel pipe can be used as a mast with no drawbacks or special adaptation.

4.3.1 Non-Frangible Tower Installations

For non-frangible tower installations, install an appropriately-sized mast so that the sensor optics will be 10 ft ± 2 ft (3 m ± 0.6 m) above ground, or 6.5 ft (2 m) above the average maximum snow depth, whichever is higher.

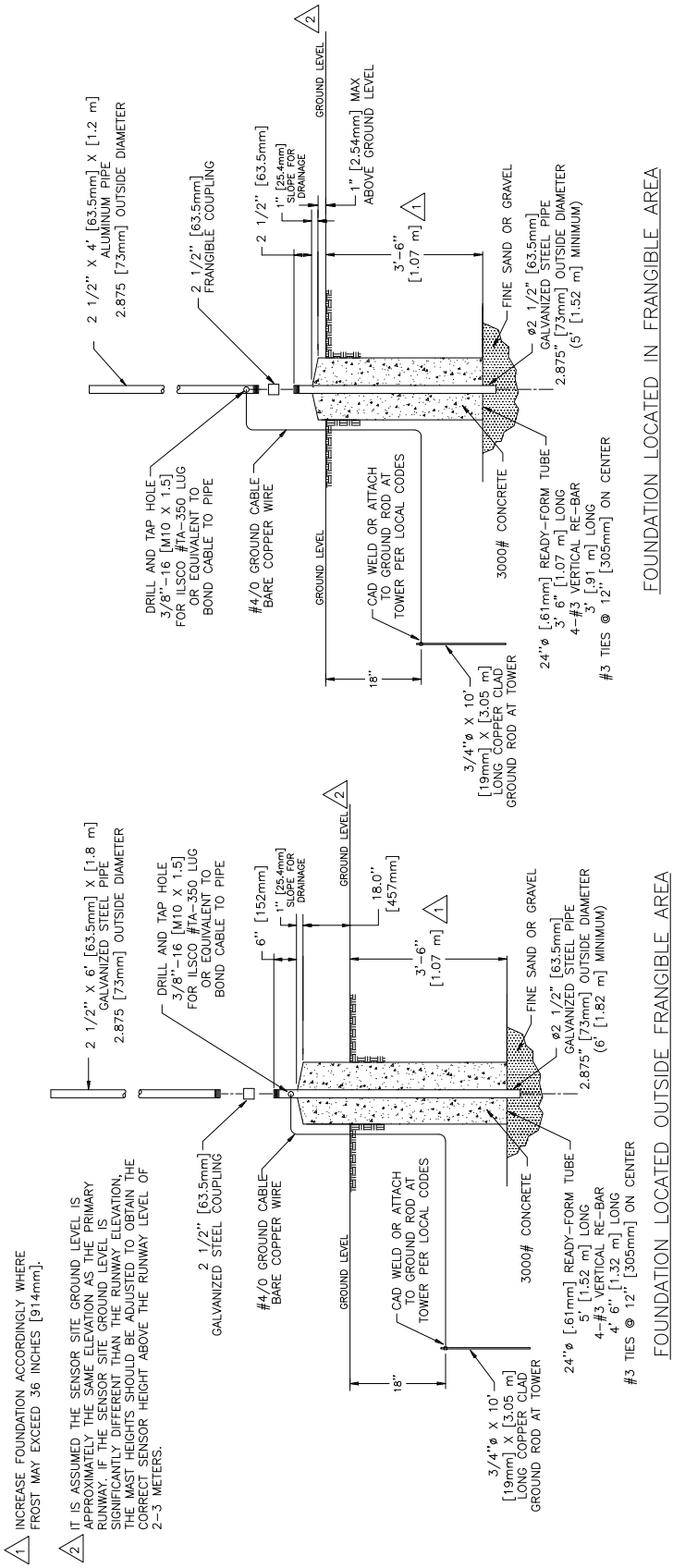

1 INCREASE FOUNDATION ACCORDINGLY WHERE FROST MAY EXCEED 36 INCHES [914mm].
2 IT IS ASSUMED THE SENSOR SITE GROUND LEVEL IS APPROXIMATELY THE SAME ELEVATION AS THE PRIMARY RUNWAY. IF THE SENSOR SITE GROUND LEVEL IS SIGNIFICANTLY DIFFERENT THAN THE RUNWAY ELEVATION, THE MAST HEIGHTS SHOULD BE ADJUSTED TO OBTAIN THE CORRECT SENSOR HEIGHT ABOVE THE RUNWAY LEVEL OF 2-3 METERS.
2 1/2" X 6' [63.5mm] X [1.8 m] GALVANIZED STEEL PIPE 2.875 [73mm] OUTSIDE DIAMETER
DRILL AND TAP HOLE 3/8"-16 [M10 X 1.5] FOR ILSCO #TA-350 LUG OR EQUIVALENT TO BOND CABLE TO PIPE
6" [152mm]
1" [25.4mm] SLOPE FOR DRAINAGE
GROUND LEVEL
18.0" [457mm]
3'-6" [1.07 m]
2 1/2" [63.5mm] GALVANIZED STEEL COUPLING
#4/0 GROUND CABLE BARE COPPER WIRE
CAD WELD OR ATTACH TO GROUND ROD AT TOWER PER LOCAL CODES
FINE SAND OR GRAVEL
3000# CONCRETE
Ø2 1/2" [63.5mm] GALVANIZED STEEL PIPE 2.875" [73mm] OUTSIDE DIAMETER (6' [1.82 m] MINIMUM)
24"ø [.61mm] READY-FORM TUBE 5' [1.52 m] LONG 4-#3 VERTICAL RE-BAR 4' 6" [1.32 m] LONG #3 TIES @ 12" [305mm] ON CENTER
3/4"ø X 10' [19mm] X [3.05 m] LONG COPPER CLAD GROUND ROD AT TOWER
FOUNDATION LOCATED OUTSIDE FRANGIBLE AREA
2 1/2" X 4' [63.5mm] X [1.2 m] ALUMINUM PIPE 2.875 [73mm] OUTSIDE DIAMETER
DRILL AND TAP HOLE 3/8"-16 [M10 X 1.5] FOR ILSCO #TA-350 LUG OR EQUIVALENT TO BOND CABLE TO PIPE
2 1/2" [63.5mm] FRANGIBLE COUPLING
2 1/2" [63.5mm]
1" [25.4mm] SLOPE FOR DRAINAGE
GROUND LEVEL
1" [2.54mm] MAX ABOVE GROUND LEVEL
3'-6" [1.07 m]
#4/0 GROUND CABLE BARE COPPER WIRE
CAD WELD OR ATTACH TO GROUND ROD AT TOWER PER LOCAL CODES
FINE SAND OR GRAVEL
3000# CONCRETE
Ø2 1/2" [63.5mm] GALVANIZED STEEL PIPE 2.875" [73mm] OUTSIDE DIAMETER (5' [1.52 m] MINIMUM)
24"ø [.61mm] READY-FORM TUBE 3' 6" [1.07 m] LONG 4-#3 VERTICAL RE-BAR 3' [.91 m] LONG #3 TIES @ 12" [305mm] ON CENTER
3/4"ø X 10' [19mm] X [3.05 m] LONG COPPER CLAD GROUND ROD AT TOWER
FOUNDATION LOCATED IN FRANGIBLE AREA

Figure 4. Mast Installation

4.3.2 Frangible Tower Installations

For frangible tower installations, install an appropriately-sized mast so that the sensor optics will be 6.5 ft ± 6" (2 m ± 0.15 m) above ground.

4.3.3 Mast Foundation

Construct a foundation for the mast according to the details in Figure 4, using the drawing corresponding to the type of mast used (frangible or non-frangible). When embedding the mast in the concrete, make sure the mast is vertical to within ± 2 degrees. Bevel all pad edges.

4.4 CONDUIT AND JUNCTION BOXES

For most installations, conduit should be routed to the sensor to accommodate the power line to the sensor and the signal line from the sensor to the host computer or DCP. For ease of connection, junction boxes can be installed near the base of the mast, and rigid or flex conduit are installed between the junction boxes and the Visibility Controller Assembly. Refer to Figure 5 for the conduit and junction box installation details.

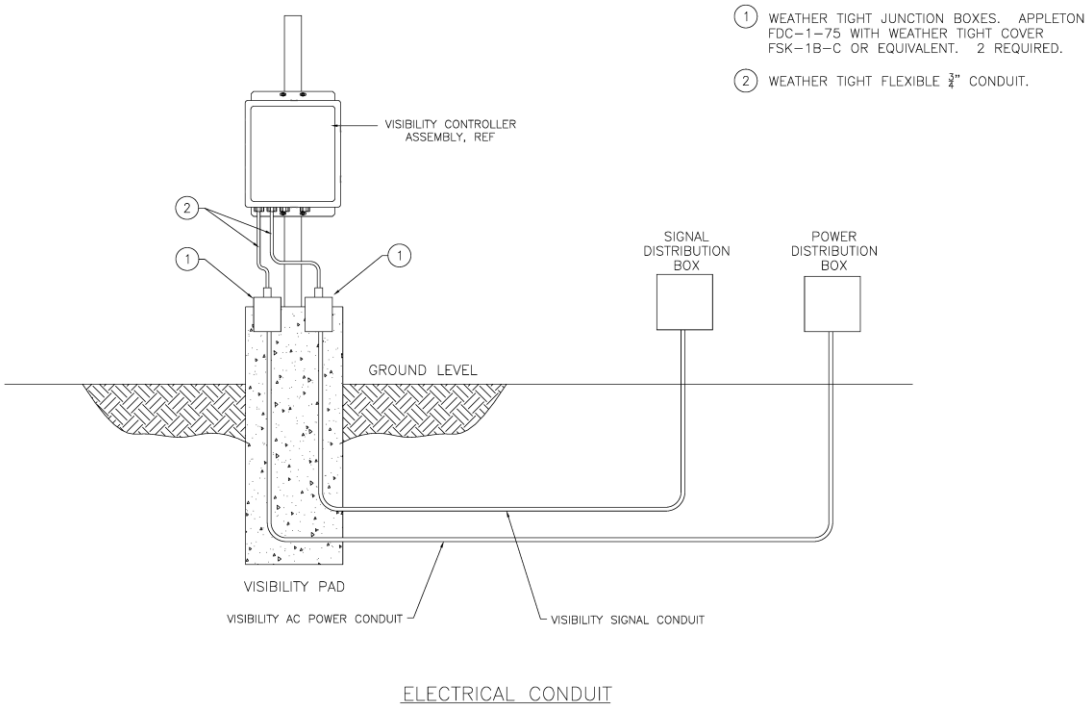

1 WEATHER TIGHT JUNCTION BOXES. APPLETON FDC-1-75 WITH WEATHER TIGHT COVER FSK-1B-C OR EQUIVALENT. 2 REQUIRED.
2 WEATHER TIGHT FLEXIBLE ¾" CONDUIT.
VISIBILITY CONTROLLER ASSEMBLY, REF
SIGNAL DISTRIBUTION BOX
POWER DISTRIBUTION BOX
GROUND LEVEL
VISIBILITY PAD
VISIBILITY AC POWER CONDUIT
VISIBILITY SIGNAL CONDUIT
ELECTRICAL CONDUIT

Figure 5. Conduit and Junction Box Installation

4.5 SIGNAL AND POWER CONNECTIONS

Power and signal connections from the sensor heads are already terminated in the visibility sensor controller enclosure. The Ambient Light Sensor (ALS) mounted on one of the sensor heads is connected inside the visibility sensor controller enclosure. Separate power and signal connections for the ALS are not required.

4.6 VISIBILITY SENSOR INSTALLATION

Follow the instructions below for assembling and installing the sensor.

1. (See Figure 6) Install the mounting plate/sleeve assembly onto the mast, sliding the mast into the mounting sleeve. Temporarily tighten the two bolts to secure the sleeve to the mast.

Figure 6. Mounting Plate/Sleeve Installation

2. (See Figure 7) Place crossarm 1 (the crossarm with the "POLE" label) onto the mounting plate with the label oriented as shown in Figure 7.

   Note that all steps that reference pointing toward the "POLE" refer to pointing to the closest geographic pole (North or South depending on the installation location relative to the equator).

Figure 7. Crossarm 1 installation

3. Orient the crossarm diagonally on the plate so that the mounting holes in the crossarm align with the upper-right and lower-left holes in the mounting plate (see Figure 8).
4. Place the Middle Plate on the crossarm as shown in Figure 8.

Figure 8. Middle Plate Installation

5. Place crossarm 2 (crossarm with the "EQUATOR" label) onto the middle plate with the "EQUATOR" label oriented in the opposite direction from the "POLE" label on crossarm 1.
6. Orient the crossarm diagonally on the plate so that the mounting holes in the crossarm align with the upper-left and lower-right holes in the mounting plate (see Figure 9).
7. Install one 5/16 x 5" long bolt with flat and lock washer through the center hole of both crossarms and both plates as shown in Figure 9. Tighten the bolt finger tight.

Figure 9. Crossarm 2 Installation

8. Rotate the crossarms and plates as necessary to line up all the remaining mounting holes.

9. Install one 5/16 x 5" long bolt, one 2" spacer, and one 5/16 x 2 ¾" long bolt with flat and lock washers in the positions shown in Figure 10. Tighten the bolts finger tight. ***Note: Figure 10 shows the assembly viewed from the "EQUATOR" end of the crossarms.***

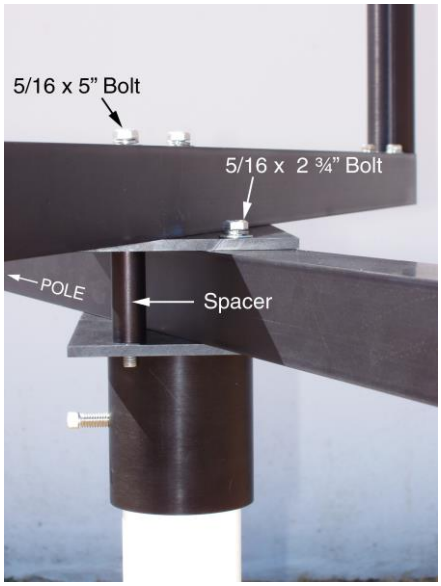


Figure 10. Crossarm bolt and spacer installation part 1, viewed from the "EQUATOR" end of the crossarms

10. Set two spacers in place on the mounting plates as shown in Figure 11. ***Note: Figure 5 shows the assembly viewed from the "POLE" end of the crossarms.***
11. Position the paddle angle mount with the vertical plate toward the equator end of the sensor (see Figure 11).
12. Install two 5/16 x 5" long bolts with flat and lock washers through the paddle angle mount, spacers, crossarms, and plates as shown in Figure 11.

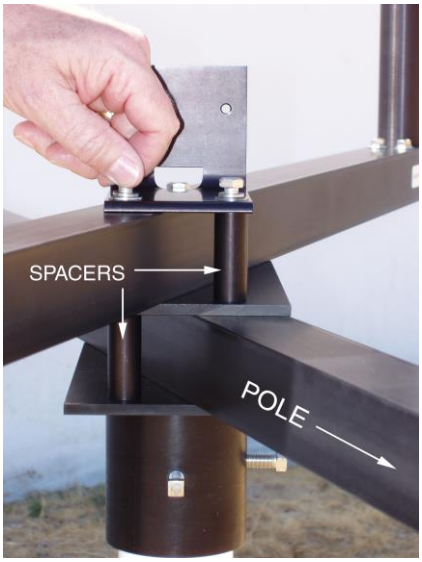


Figure 11. Crossarm bolt and spacer installation part 2, viewed from the "POLE" end of the crossarms

13. Tighten the five bolts evenly in a crisscross sequence.
14. The final assembly should look like Figure 12.

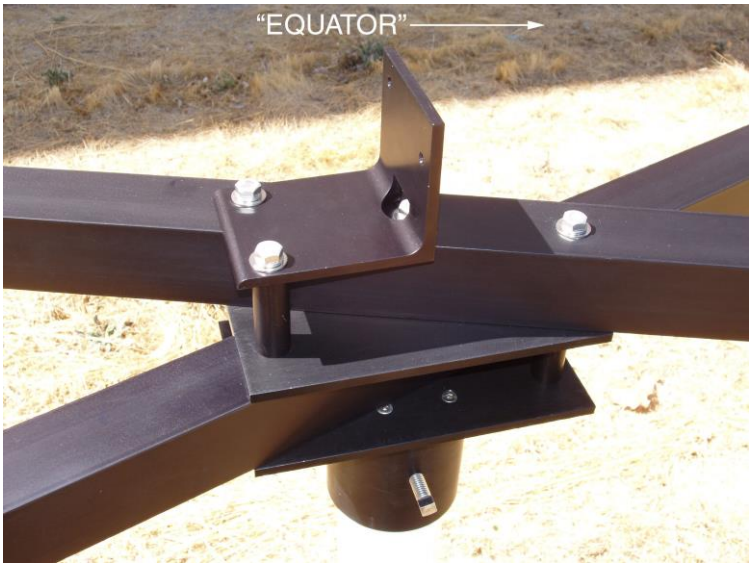


Figure 12. Final Assembly View

15. Loosen the two bolts securing the crossarm assembly to the mast and rotate the crossarm assembly to approximately align the "EQUATOR" end of the crossarm to the equator. Retighten the two bolts.
16. Each of the four sensor uprights is fitted with a plastic sleeve that fits inside the upright. Ensure that the slots in the sleeves align with the V-notches on the uprights (see Figure 13).

Figure 13. Aligning the inner sleeve slot with the sensor head notch

17. The emitter and detector sensor heads and uprights are labeled as EMITTER 0, EMITTER 1, DETECTOR 0, and DETECTOR 1. When installed, the labels on the sensor heads and the uprights must match.
18. Route the cable from each head through the top of the matching upright, then out the oblong hole in the side of the upright as shown in Figure 14.

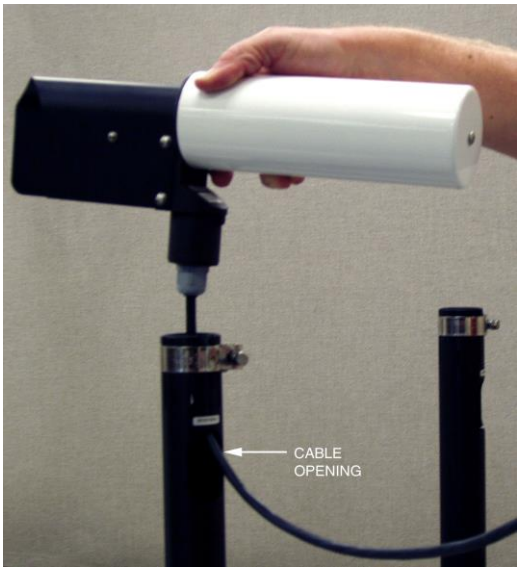


Figure 14. Routing the sensor head cable through the upright opening

19. Slide the sensor head down into the top of the upright so that the key on the head fits into the V-notch on the upright.
20. If not seated properly, the sensor head has a tendency to tilt backward. To properly seat the head in the upright, apply downward pressure on the sensor head as you tighten the head clamp as shown in Figure 15.

Figure 15. Securing the sensor head

21. Feed the sensor cables along the underside of the crossarm to the Visibility Controller Assembly enclosure. The free end of the cable will be connected to the Visibility Controller Board after the controller is installed.
22. For each of the four heads, pull enough slack in the cable to put your finger between the cable and the upright just below the hole. Secure the cable with a cable tie about two inches below the bottom of the hole, so that the slack remains and the cable does not rest against the bottom edge of the hole. Continue down the uprights and along the undersides of the crossarms, securing the cables with cable ties.
23. Just below the crossarms, wrap the cables about 1/2 to 3/4 turn around the mast, and secure the cables below this wrap with cable ties. This will allow the crossarms to be rotated during future calibrations without having to cut and replace the cable ties.

4.7 VISIBILITY CONTROLLER ASSEMBLY INSTALLATION

The Visibility Controller Assembly mounts on the mast below the sensor using the mounting hardware included with the enclosure.

1. In installations where a non-frangible tower is used, mount the Visibility Controller Assembly on the mast with the top of the enclosure 5'6" (167 cm) from ground level, or at least 3 ft (1 m) above maximum snow level. In installations where a frangible tower is used, mount the Visibility Controller Assembly on the mast with the top of the enclosure 3'6" (107 cm) from ground level. Attach the Visibility Controller Assembly enclosure to the mast using mounting hardware as shown in Figure 16.
2. Cables are identified with labels at their ends. Route the cables through the four strain reliefs on the bottom of the controller enclosure as shown in Figure 17 by folding the connector back over the cable and bending the cable 90° (see Figure 18). This will enable the connector and cable to fit through the strain relief nut and grommet and through the strain relief itself into the enclosure.
3. Connect the sensor cables to the corresponding connectors on the Visibility Controller Board as shown in Figure 19. Care must be taken to ensure that the cables are properly installed prior to connecting power.

The Visibility Controller Assembly mounts to the visibility sensor mast beneath the sensor crossarm using the mounting hardware.

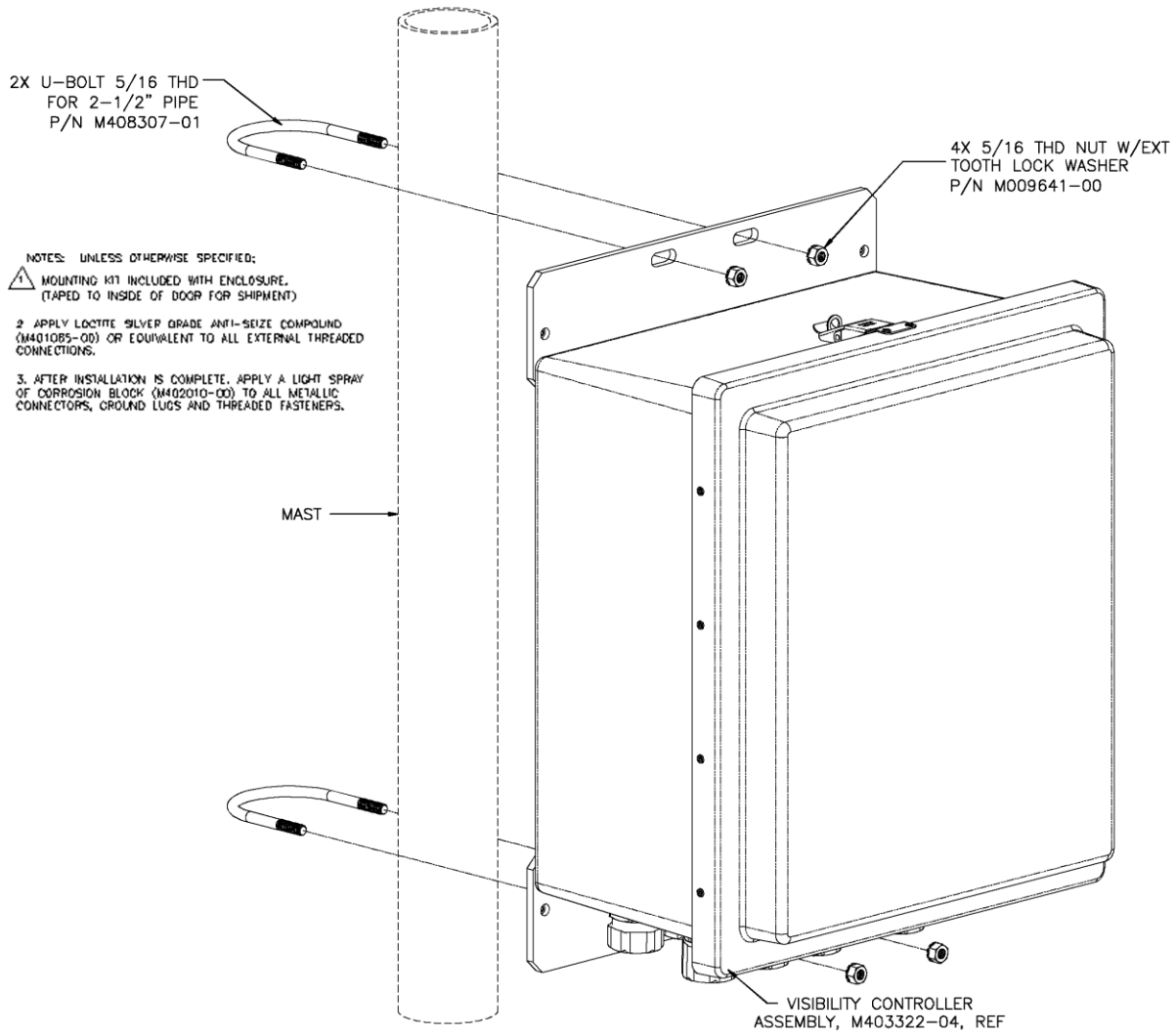

2X U-BOLT 5/16 THD
FOR 2-1/2" PIPE
P/N M408307-01
4X 5/16 THD NUT W/EXT
TOOTH LOCK WASHER
P/N M009641-00
NOTES: UNLESS OTHERWISE SPECIFIED:
1. MOUNTING KIT INCLUDED WITH ENCLOSURE.
(TAPED TO INSIDE OF DOOR FOR SHIPMENT)
2. APPLY LOCTITE SILVER GRADE ANTI-SEIZE COMPOUND
(M401085-00) OR EQUIVALENT TO ALL EXTERNAL THREADED
CONNECTIONS.
3. AFTER INSTALLATION IS COMPLETE, APPLY A LIGHT SPRAY
OF CORROSION BLOCK (M402010-00) TO ALL METALLIC
CONNECTORS, GROUND LUGS AND THREADED FASTENERS.
MAST
VISIBILITY CONTROLLER
ASSEMBLY, M403322-04, REF

Figure 16. Mounting Visibility Controller Assembly on Mast

The emitters and detectors are located in relation to one another as shown, and the sensor cables secured with cable ties to the underside of the cross member. Cables enter the controller enclosure through strain reliefs on the enclosure's underside. Ground the sensor as shown in the detail.

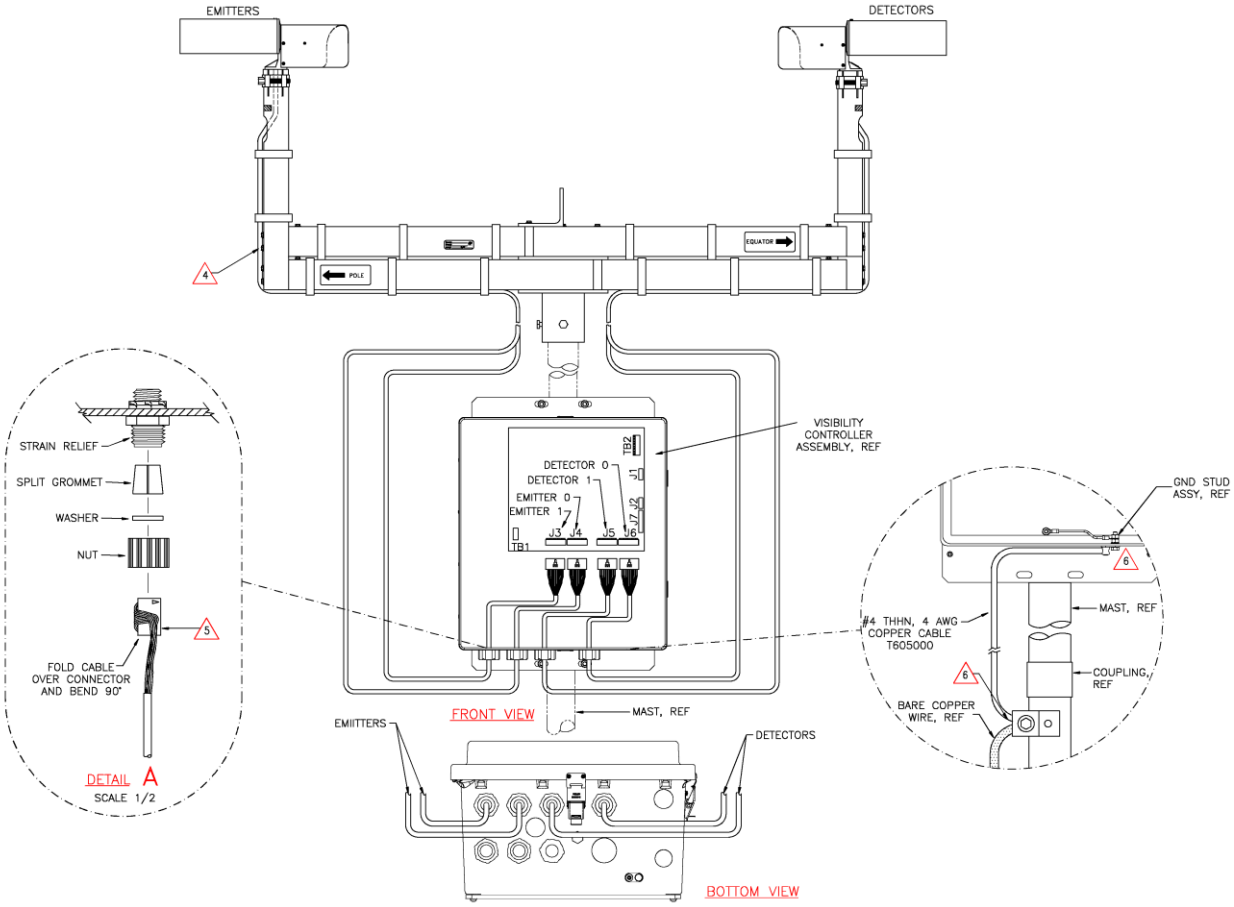


Figure 17. Assembling Emitter and Detector Heads

Carefully fold the head connectors back over the wires and feed them through the strain reliefs.

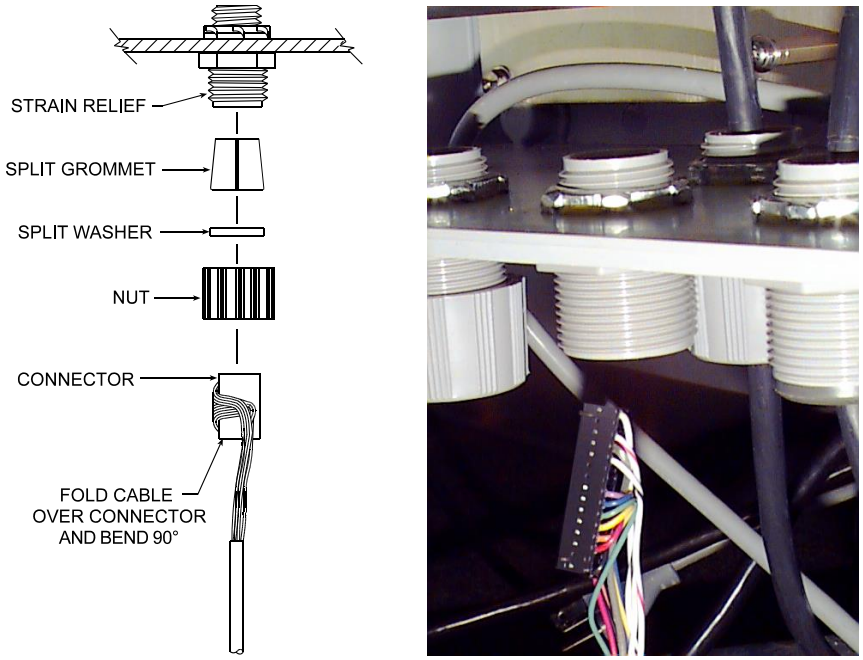


Figure 18. Feed Cables Through Cable Glands in Enclosure

Connect the sensor head cables to the connectors on the Visibility Controller Board as shown.

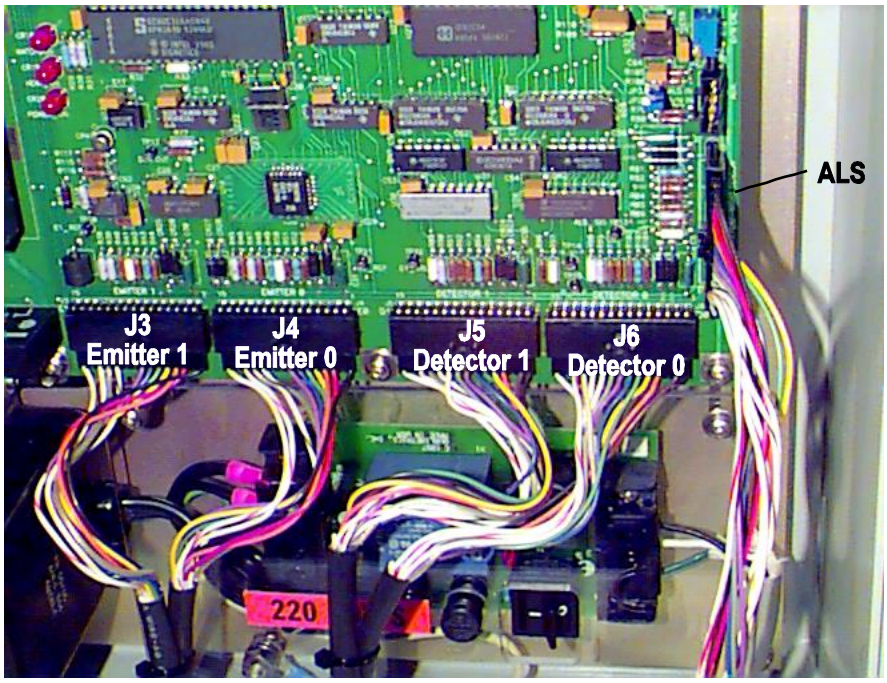


Figure 19. Cable Connection on the Visibility Controller Board

4.7.1 Power Connection

! WARNING !

NEVER INSTALL OR REMOVE A CABLE
WITH POWER APPLIED.

THIS SENSOR IS A 110VAC DEVICE.

CONNECT TO 220V ONLY IF 220VAC KIT M488174
IS INSTALLED.

The 8365 is a 115 V AC device. An optional 220 V AC kit (M488174) is available for installations where the supply power is 220 V. Do not connect 220 V without a 220 V kit installed.

To connect power to the 8365 controller, follow the steps below.

1. Route power for the sensor through conduit or through a 3/8" strain relief installed in one of the two left side cutouts (when viewed from below with the door up, as in Figure 17) on the underside of the Visibility Controller Board.
2. Terminate the AC power cable to TB1 on the Visibility Controller Board as shown in Figure 20.

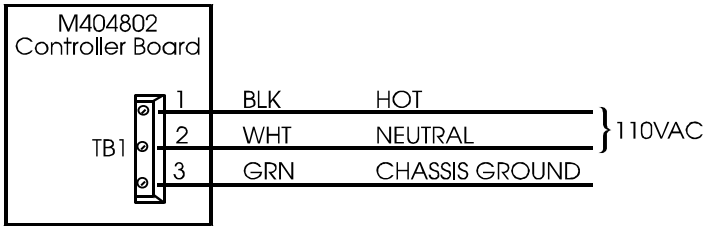


Figure 20. Visibility Controller Board Power Connections

4.7.2 Ground Cable Installation

In order for the sensor's built-in lightning protection to function properly, the Visibility Controller Board must be grounded as shown in Figure 21. To install grounding, follow the steps below.

1. Drill and tap a 3/8-16 hole in the mast. Install a grounding clamp in the hole.
2. Inside the enclosure, use a short length of ground cable (4 AWG multi-strand insulated wire, available from All Weather Inc. as P/N T605000) to connect the ground lug on the bottom center of the Visibility Controller Board to the ground stud near the bottom inside the Visibility Controller enclosure.
3. Route a 10 ft length of ground cable to the ground lug at the bottom of the Visibility Controller enclosure.
4. Connect the other end of the ground cable to the ground clamp on the mast.

5. Finally, connect a bare copper ground wire between the ground rod and the ground clamp on the mast.

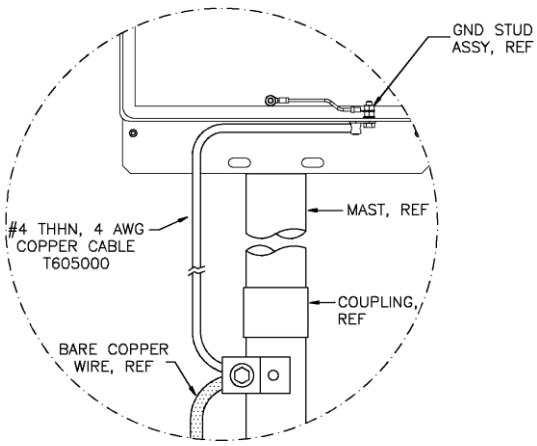


Figure 21. Ground Cable Installation

4.7.3 220 V AC Kit Installation

(See Figure 22) The M488174 220 V AC kit provides a step-down transformer to allow the 8365 to run from a 220 V AC supply. (*Note: This kit is normally installed at the factory*.)

1. Remove the existing cable installed between TB1 and TB2 on the Visibility Controller Board.
2. The transformer mounts to the Visibility Controller Board, in the lower left corner as shown in Figure 22, to the four studs protruding up from the board. Leave the existing nuts installed on the studs. Set the transformer in place over the studs so that it rests on the nuts. Secure the transformer with a flat washer, lock washer, and nut at each corner.
3. Trim the three wires extending from the transformer's primary side to approximately 6" and attach spade lugs.
4. Form a service loop in the primary wires (to which you just attached spade lugs) and connect to terminals 1, 2, and 3 of TB2 as shown in Figure 22.

   smooth BLACK (line) to pin 1
   ridged BLACK (neutral) to pin 2
   GREEN (ground) to pin 3
5. Cut the wires from the transformer's secondary side to approximately 6", and strip the ends. Connect to pins 1, 2, and 3 of TB1 as shown in Figure 22.

   smooth BLACK to pin 1
   ridged BLACK to pin 2
   GREEN (ground) to pin 3
6. Install the "**220 VOLTS**" sticker over the AC power selector switch. The position of this switch does not matter.

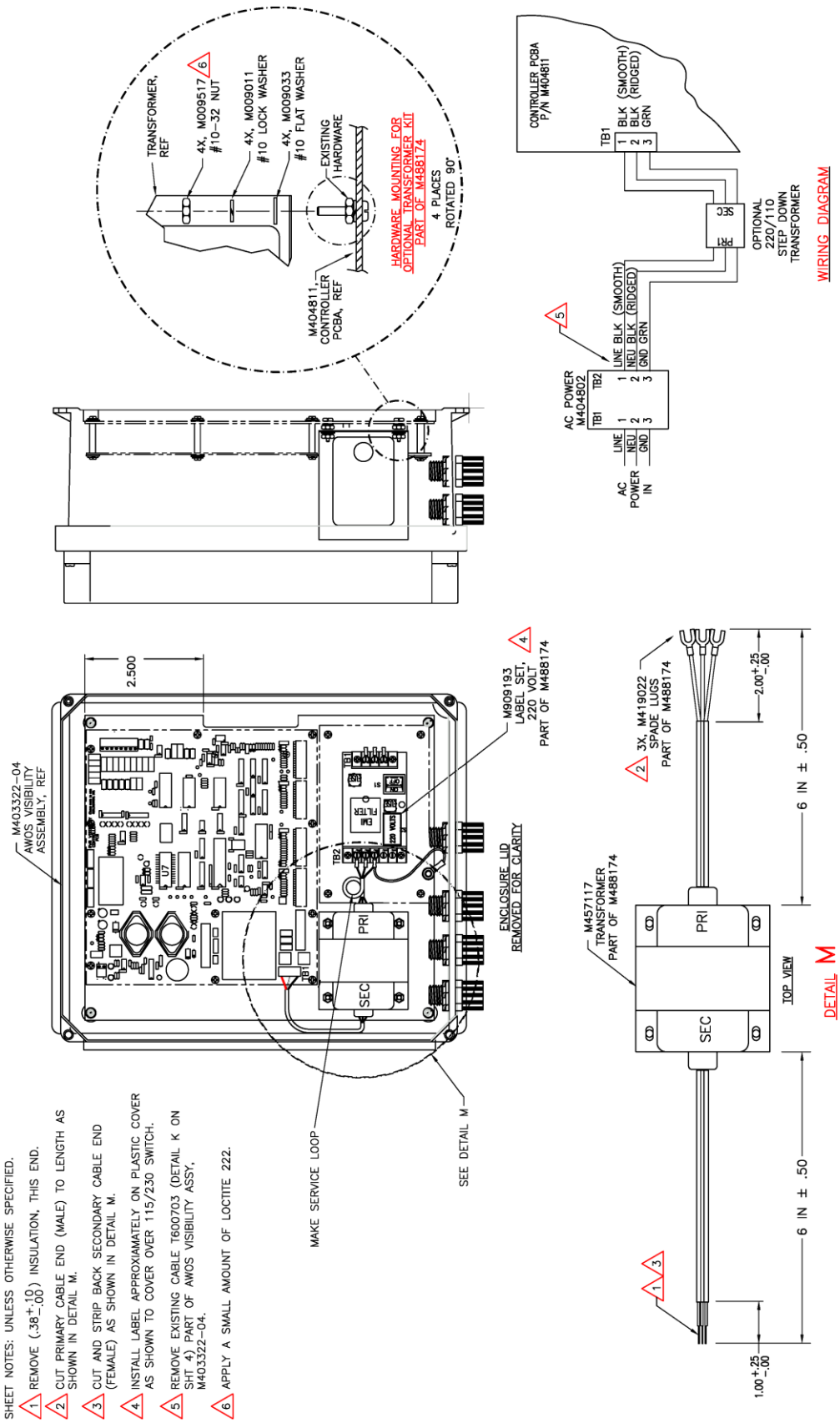

SHEET NOTES: UNLESS OTHERWISE SPECIFIED.
1 REMOVE (.38 +.10 -.00) INSULATION, THIS END.
2 CUT PRIMARY CABLE END (MALE) TO LENGTH AS SHOWN IN DETAIL M.
3 CUT AND STRIP BACK SECONDARY CABLE END (FEMALE) AS SHOWN IN DETAIL M.
4 INSTALL LABEL APPROXIAMATELY ON PLASTIC COVER AS SHOWN TO COVER OVER 115/230 SWITCH.
5 REMOVE EXISTING CABLE T600703 (DETAIL K ON SHT 4) PART OF AWOS VISIBILITY ASSY, M403322-04.
6 APPLY A SMALL AMOUNT OF LOCTITE 222.
TRANSFORMER, REF
4X, M009517 #10-32 NUT
4X, M009011 #10 LOCK WASHER
4X, M009033 #10 FLAT WASHER
EXISTING HARDWARE
4 PLACES ROTATED 90°
HARDWARE MOUNTING FOR OPTIONAL TRANSFORMER KIT PART OF M488174
M404811, CONTROLLER PCBA, REF
CONTROLLER PCBA P/N M404811
TB1
1 BLK (SMOOTH)
2 BLK (RIDGED)
3 GRN
SEC
PRI
OPTIONAL 220/110 STEP DOWN TRANSFORMER
WIRING DIAGRAM
AC POWER M404802
TB1 TB2
LINE 1 LINE BLK (SMOOTH)
NEU 2 NEU BLK (RIDGED)
GND 3 GND GRN
AC POWER IN
LINE
NEU
GND
2.500
M403322-04 AWOS VISIBILITY ASSEMBLY, REF
M909193 LABEL SET, 220 VOLT PART OF M488174
ENCLOSURE LID REMOVED FOR CLARITY
MAKE SERVICE LOOP
SEE DETAIL M
PRI
SEC
TB2
FILTER
3X, M419022 SPADE LUGS PART OF M488174
M457117 TRANSFORMER PART OF M488174
2.00 +.25 -.00
6 IN ± .50
6 IN ± .50
1.00 +.25 -.00
TOP VIEW
DETAIL M
INSTALLATION INSTRUCTIONS FOR OPTIONAL 220 TRANSFORMER KIT M488174

Figure 22. 220 V AC Kit Installation

The setup described above completes the installation of the 220 V AC Kit when the 8365 will be connected to a power source protected by a ground-fault interrupt (GFI). In areas subject to lightning strikes where the power source has no GFI protection, add a jumper to the power connector on the Visibility Controller Board (see Figure 23). Use a solid wire about 18 gauge (1 mm). If stranded wire is used, just break off strands until the wire will fit in the hole along with the existing wire.

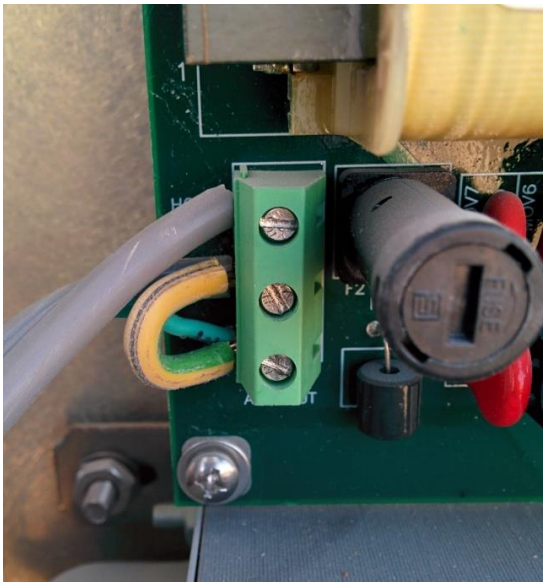


Figure 23. Add Jumper Wire to Visibility Controller Board for Lightning Mitigation

4.7.4 Signal Connections

The RS-485 and RS-232 outputs are available on terminal block TB2 on the Visibility Controller Board. The connections are shown in Table 1.

Table 1. TB2 Serial Output Pin Designations

TB2 Pin	Description
1	RS-485 (-)
2	RS-485 (+)
3	RS-232 Tx Data
4	RS-232 RTS
5	RS-232 Rx Data
6	RS-232 CTS
7	RS-232 GND
8	Chassis GND

An explanation of the output data stream in both standard and AWOS formats is provided in Table 3 and Table 4.

For AWOS systems, route the data cable to the DCP. Refer to the ***1190 DCP User's Manual*** (1190-001) for instructions on connecting the data cable to the DCP.

4.8 POWERING UP THE SENSOR

Once the sensor and controller are installed, and power and signal lines have been connected, turn on the power switch inside the Visibility Controller Assembly. The sensor will begin collecting and processing data.

4.9 OPTIONAL KITS

The following sections provide installation instructions for the optional feature kits available with the 8365. For detailed descriptions of the kits and their uses, refer to ***Chapter 13***.

4.9.1 Ambient Light Sensor Kit Installation

(See Figure 24) The Ambient Light Sensor (ALS) mounts to a mounting block attached about halfway up the EMITTER 0 upright.

1. Disconnect the EMITTER 0 cable from J7 on the Visibility Controller Board.
2. Remove the EMITTER 0 sensor head, including the cable, from the sensor upright.
3. Remove the mounting clamp from the EMITTER 0 upright.
4. Slide the adapter over the upright, so that the upright fits through the hole in the upright mounting block.
5. Slide the adapter about halfway down the upright, and orient it so that the ALS head will be pointing toward the "POLE" when installed (see Figure 24).

   Note that all steps that reference pointing toward the "POLE" refer to pointing to the closest geographic pole (North or South depending on the installation location relative to the equator).
6. Secure the mount by tightening the two screws in the upright mounting block.
7. Route the ALS cable through the hole in the head mounting block, and set the head into place with the key in the head resting in the notch in the mounting block. Tighten the screw in the head mounting block.
8. If the head is not pointing toward the "POLE", loosen the two screws in the upright mounting block and rotate the head and adapter as necessary to orient the head toward the "POLE". Tighten the two screws.
9. Install a strain relief in the top right hole of the enclosure when seen from below.
10. Remove the nut, washer and grommet from the strain relief.
11. Route the cable through the nut, washer, and grommet by folding the cable back over the connector, then bending the cable 90° so that the profile of the cable end and connector is small enough to fit through the nut and strain relief.
12. With the cable still folded over the connector, feed the cable through the strain relief and into the enclosure.

Note that "POLE" refers to pointing to the closest geographic pole (North or South depending on the installation location relative to the equator).

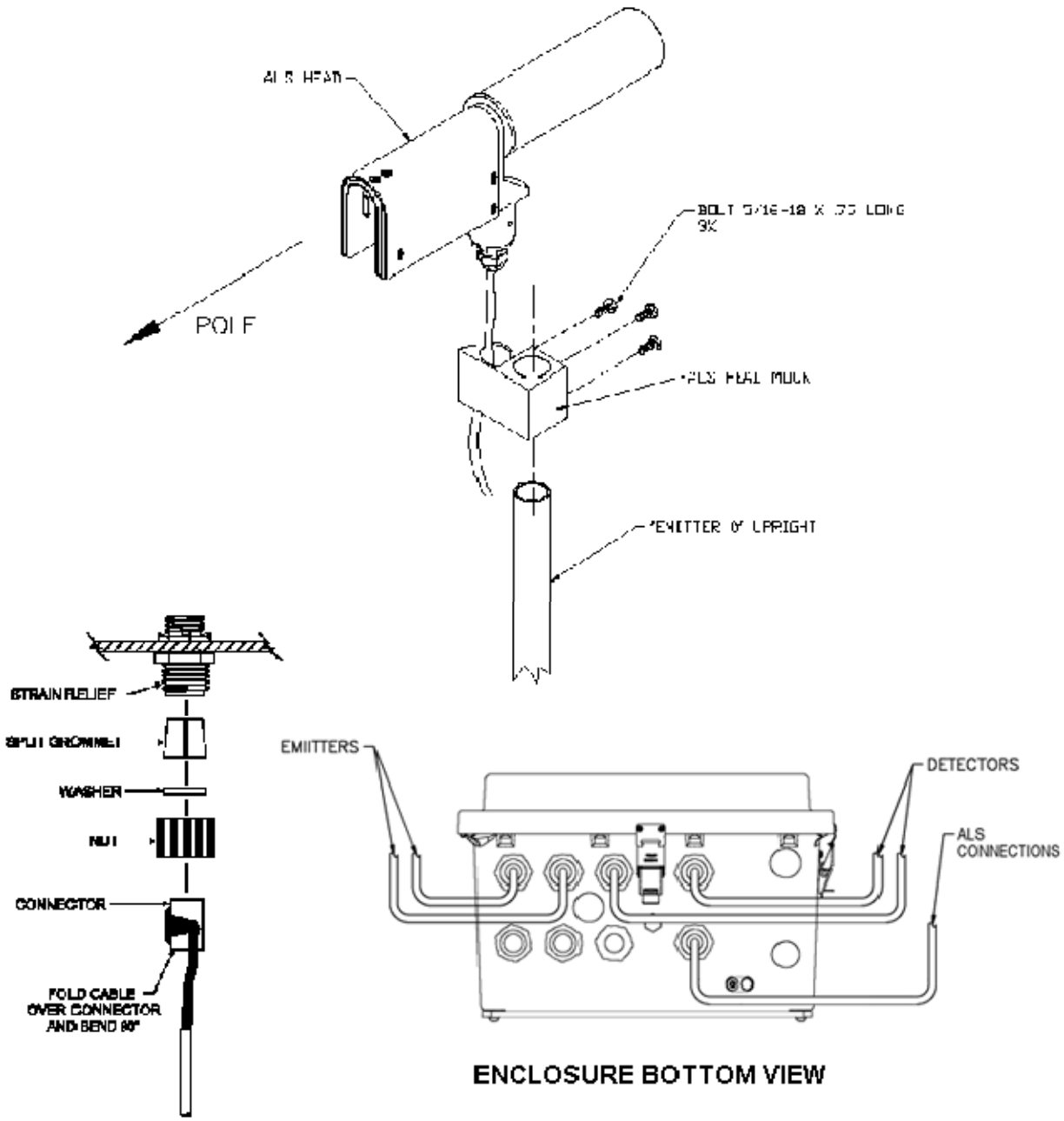


Figure 24. ALS Sensor Installation

13. Plug the connector into the ALS connector (J10) on the Visibility Controller Board (see Figure 25).

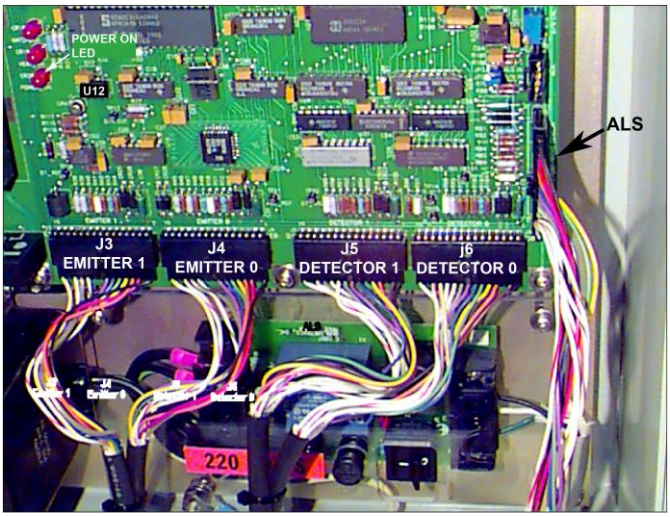


Figure 25. Visibility Controller Board ALS Connection

14. Replace the EMITTER 0 mounting clamp on the upright.
15. Reinstall the EMITTER 0 sensor head.
16. Reconnect the EMITTER 0 sensor cable to J7 on the Visibility Controller Board.
17. If the ALS is added to an already-installed 8365, it will be delivered calibrated from the factory. An EEPROM containing calibration data for the ALS is included in the package. Install this EEPROM in socket U12 on the Visibility Controller Board (U12 is located in a socket to the left of the header J1 connector near the middle right side of the Visibility Controller Board). If an EEPROM is already installed in U12, remove the existing EEPROM and install the new EEPROM in its place. Perform the visibility calibration procedure described in Chapter 8 to set the correct calibration factor in the EEPROM.

4.9.2 Day/Night Sensor Kit Installation

(See Figure 24) The Day/Night sensor installs on the underside of the Visibility Controller Assembly enclosure and connects to J7 on the Visibility Controller Board.

1. Remove the sealing nut from the Day/Night sensor's threaded neck.
2. To make the cable end and connector profile small enough to fit through the cutout in the bottom of the enclosure, fold the cable back over the connector, then bend the cable 90° as shown in Figure 24.
3. With the cable still folded over the connector, feed the cable through the far right cutout in the underside of the enclosure (when seen from below with the door topmost) and into the enclosure.
4. Feed the rest of the cable into the enclosure, and insert the sensor into the cutout so that the threaded neck is inside.
5. Inside the enclosure, feed the cable through the sealing nut and thread the nut onto the sensor neck. Tighten the nut snugly so that the sensor is tight against the base of the enclosure.
6. Plug the connector into J7 on the Visibility Controller Board.
7. Install jumper JP2; remove jumper JP3.
8. Align the sensor to North in the Northern Hemisphere and South in the Southern Hemisphere by rotating the Visibility Controller Assembly enclosure as necessary so that the sensor's photoelectric eye faces North or South as required, with an unobstructed field of view.

Note that the Day/Night sensor is not a field replaceable unit. The sensor is calibrated in conjunction with the Visibility Controller Board, and so a calibration must be done if either the Visibility Controller Board or the Day/Night sensor is replaced. This calibration can only currently be done by All Weather, Inc.

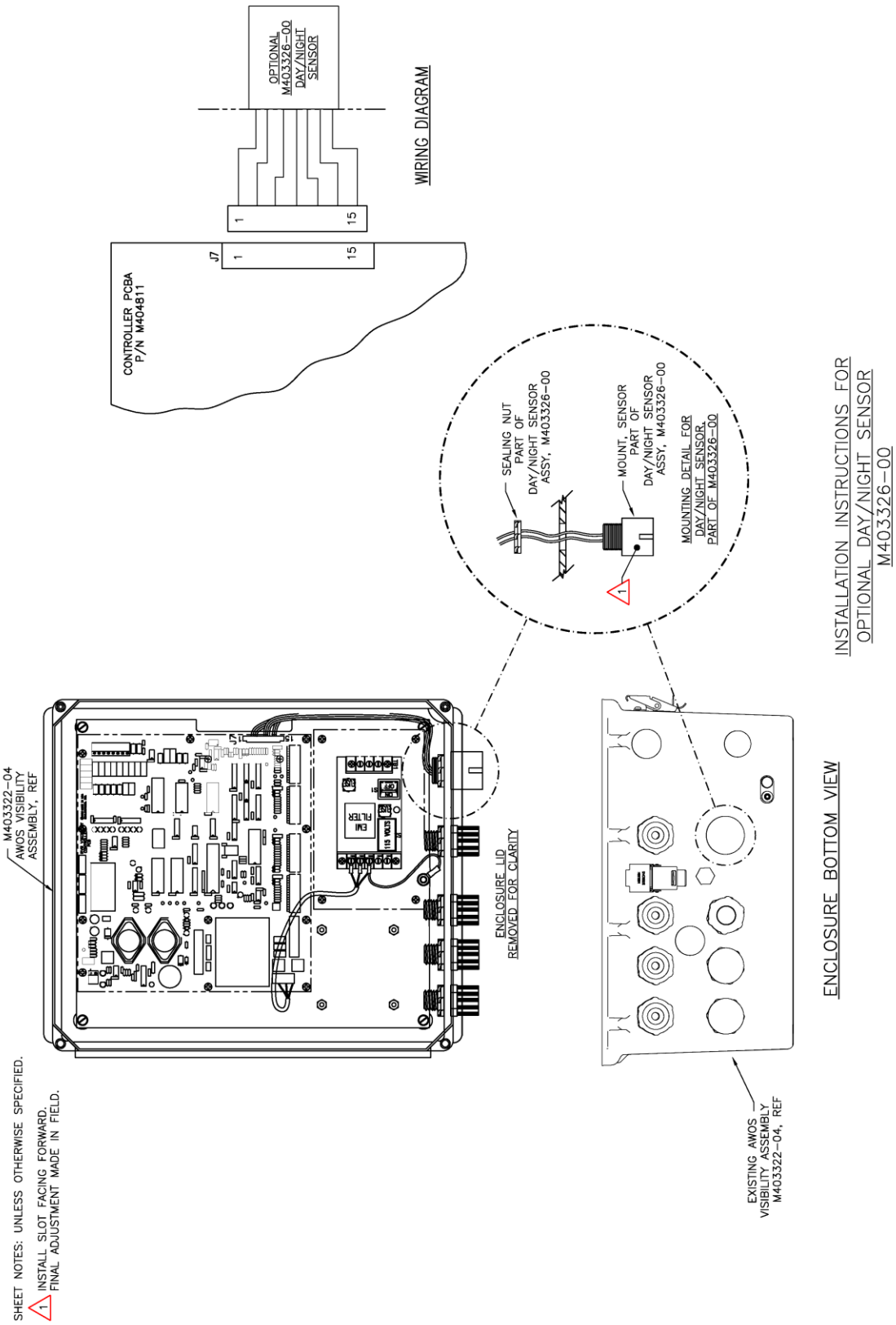

WIRING DIAGRAM
OPTIONAL M403326-00 DAY/NIGHT SENSOR
CONTROLLER PCBA P/N M404811
J7
1
15
SEALING NUT PART OF DAY/NIGHT SENSOR ASSY, M403326-00
MOUNT, SENSOR PART OF DAY/NIGHT SENSOR ASSY, M403326-00
MOUNTING DETAIL FOR DAY/NIGHT SENSOR, PART OF M403326-00
INSTALLATION INSTRUCTIONS FOR OPTIONAL DAY/NIGHT SENSOR M403326-00
M403322-04 AWOS VISIBILITY ASSEMBLY, REF
ENCLOSURE LID REMOVED FOR CLARITY
ENCLOSURE BOTTOM VIEW
EXISTING AWOS VISIBILITY ASSEMBLY M403322-04, REF
SHEET NOTES: UNLESS OTHERWISE SPECIFIED.
1 INSTALL SLOT FACING FORWARD. FINAL ADJUSTMENT MADE IN FIELD.

Figure 26. Day/Night Sensor Installation

4.9.3 Battery Backup Kit Installation

(See Figure 27) The Battery Backup Kit can provide up to 3 hours of operation at temperatures above 0° C. A charging circuit on the Visibility Controller Board maintains a full charge on the battery when AC power is present. The battery attaches to the inside of the Visibility Controller Assembly enclosure door using Velcro strips.

1. Attach a Velcro strip to the bottom of the battery, and a mating strip to the lower lip of the enclosure door, so that when installed the battery will rest on the lower edge of the door (see Figure 27).
2. Connect the wires from the battery to TB3 on the Visibility Controller Board.
   RED wire to pin 1 (+)
   BLACK wire to pin 2 (-)

Caution:
Be careful not to touch the battery leads together when connecting or handling the battery!

3. Turn the BATTERY switch (S1) on the Visibility Controller Board ON.

In the event of a loss of AC power, the backup battery will automatically become the sensor's power source. If, however, the system is powered up on battery power only, the BATTERY START switch must be depressed to initiate battery power.

The BATTERY START switch is located in the upper left of the Visibility Controller Board just to the left of the large, rectangular component U4. To initiate battery power, depress the BATTERY START button and hold it down for 3-4 seconds.

The backup battery does not power the sensor head heaters, so performance will be somewhat degraded when running from battery power in cold temperatures.

When transporting the controller, always disconnect the battery and remove it from the enclosure door before transporting.

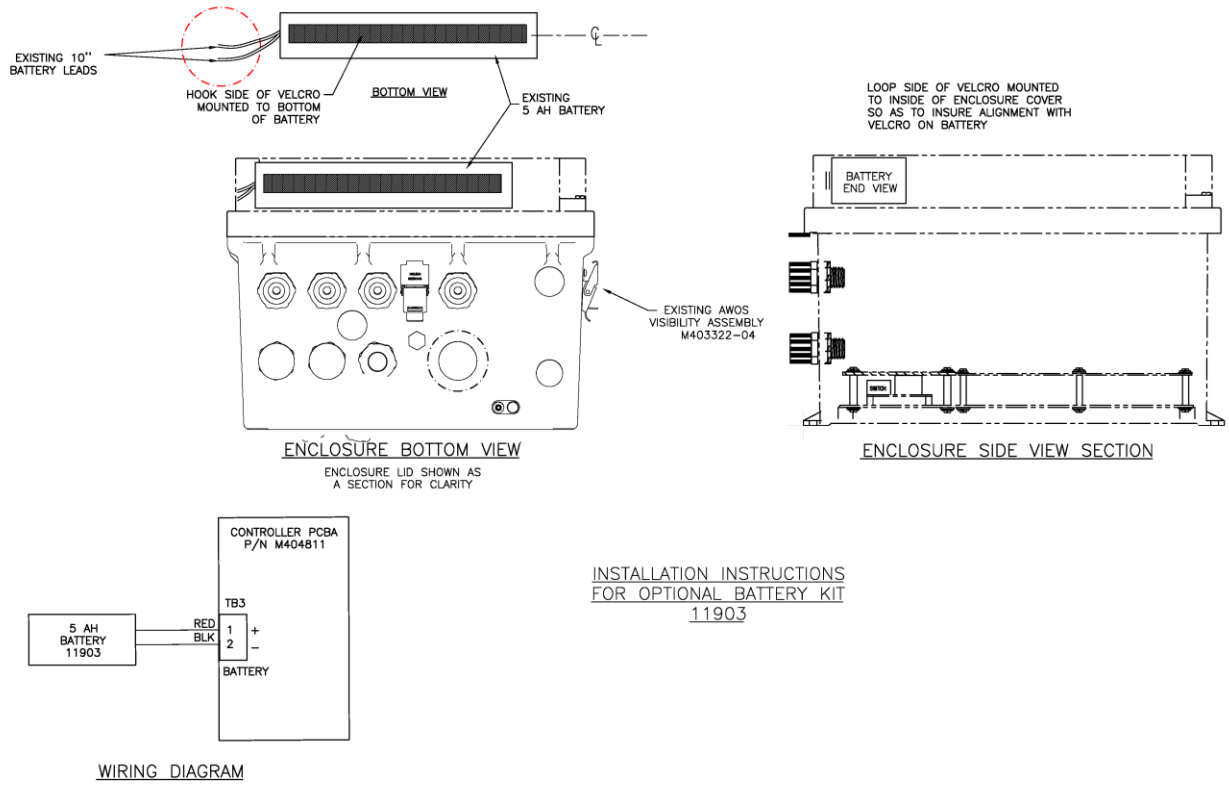


Figure 27. Battery Backup Kit Installation

4.9.4 Handheld Terminal Installation

The M403321 Handheld Terminal Kit is used to configure the visibility sensor as explained in the Chapter 8. Even though a VT52 terminal can be used (or any computer running terminal emulation software, such as Procomm), the Handheld Terminal is recommended owing to its ease of use and portability. To use the handheld terminal, connect the flat connector at the end of the cable to J1 on the Visibility Controller Board.

5. SETUP

When the visibility sensor is first installed, specific setup parameters must be entered. This is done using the optional M403321 Handheld Terminal Kit, or a VT52 terminal (or any computer running terminal emulation software, such as Procomm) connected to the Visibility Controller Board's "HANDHELD TERMINAL" port (J1). In AWOS installations, the 8365 is preconfigured and no configuration is required. Table 2 shows the standard AWOS configuration settings.

Table 2. AWOS Configuration Settings

Function	Setting	Value
Report Type	4	Standard
Output Mode	1	10 seconds
Averaging Interval	0	3 minutes
Output Type	1	Extinction coefficient
Units	0	Miles
Computer Baud Rate	1	4800 bps
Sensor Address	00	Address 00

If a VT52 terminal or computer is used in place of the Handheld Terminal, wire the interconnecting cable as shown in Figure 28. Tie the terminal's RTS and CTS lines together and tie DTR to DSR — this is necessary since handshaking is not implemented in the controller's communication protocol. The VT52 should be set to 1200 bps, 8 data bits, 1 stop bit, and no parity.

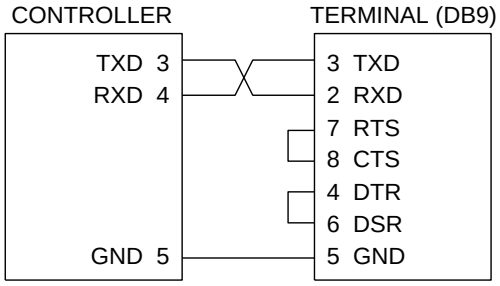


Figure 28. VT52 Connections

The Handheld Terminal connects to connector J1 on the Visibility Controller Board.

1. Open the controller enclosure door and plug the Handheld Terminal cable into J1 on the Visibility Controller Board.
2. The terminal will power up automatically. After the terminal begins receiving data from the controller, the display will change to the normal visibility output format.

5.1 SETUP MENU

To enter the Setup Menu, press the “ENT” key on the Handheld Display’s keypad or “Return” on a VT52. The following menu will appear.

```
0=EXIT   1=D/T      2=CALIB
3=TEST   4=BOOT  5=CFG
```

0=EXIT Press 0 to exit from the Setup Menu.

1=D/T Press 1 to set the correct date and time.

2=CALIB Press 2 to put the system into calibration mode. The calibration procedure is explained in detail in the Chapter 8.

3=TEST Press 3 to put the system into test mode.

4=BOOT Press 4 to perform either a software or a system reboot.

5=CFG Press 5 to enter the configuration mode.

If you make an error while making an entry, use the arrow keys to place the cursor beneath the character to be corrected and enter the new value. The new value will overwrite the old one.

5.1.1 Date/Time Setup

Enter 1 at the Setup Menu to change the time or date. The display will read:

```
0=Exit      1=Set Date
2=Set Time
```

To enter the date, press 1. The display will read:

```
Enter date ddmmyyyy
```

Enter the date in the format shown (for example, 01081998 for August 1, 1998), then press "ENT" (or “Return”). The display will return to the Date/Time menu. To enter the time, press 2 at the Date/Time menu. The display will read:

```
Enter time hhmmss
```

Enter the time in the format shown (for example, 133015 for 1:30:15 pm), then press "ENT" (or “Return”). The display will return to the Date/Time menu. To return to the main menu, press 0 at the Date/Time menu.

5.1.2 Calibration Mode

Pressing 2 at the Setup Menu will put the system into calibration mode. Refer to Chapter 8 for instructions in using this mode to calibrate the 8365.

5.1.3 Test Mode

Pressing 3 at the Setup Menu will put the system into test mode. There are five selections in the test menu:

```
0=Exit   1=Stat   2=Diag
3=Mode 0        4=Mode 1
```

These options allow for internal testing of the system in specific operational modes.

Pressing 0 (Exit) returns you to the main setup menu.

Pressing 1 (Stat) will display current values for the three status words:

```
System Status:  0048
0000  0001      #=Cont
```

The meanings of the status words are explained in Chapter 2, and in Table 5, Table 6, and Table 7. Press the # key to return to the test menu.

Pressing 2 (Diag) will initiate the diagnostics program, a series of tests of various system components (RAM, ROM, etc.). When you choose this option, a diagnostics menu will be displayed:

```
0=Exit   1=RAM    2=ROM
3=Pwr    4=NV RAM
```

To select a test to run, press the number key for that test. As the test is running, a progress message such as the following will be displayed:

```
RAM Test in
progress. . .
```

When the test is completed, a message such as the following will be displayed if the test has been successful:

```
RAM Test PASS
                        #=Cont
```

Hit the # key to return to the diagnostics menu and carry out any other tests. All the tests return a PASS or FAIL message when completed, with the Power Supply test (Pwr) returning pass or fail status for each of the three monitored power supply levels (5V, 15V, and -15V).

If any of the tests returns a FAIL message, the test has uncovered a problem that must be corrected before the sensor is put back into service.

Pressing 3 (Mode 0) places the instrument into Mode 0 with Emitter 0 on and Emitter 1 off. Detector 1 is set to the Lo gain mode for direct transmission, while Detector 0 is set into the Hi gain mode for scattered transmission. Mode 0 is used for initial alignment of the emitter/detector pair. Two values will be displayed. The "d00" value represents the indirect counts received at Detector 0. The "d01" value on the second line of the display represents the direct counts received at Detector 1.

```
Counts:         d00=927
d01=25136               #=Cont
```

This test is used in troubleshooting sensor problems, and is explained in detail in Chapter 11.

Pressing 4 (Mode 1) places the instrument into Mode 1 with Emitter 1 on and Emitter 0 off. Detector 1 is set to the Lo gain mode for direct transmission, while Detector 0 is set into the Hi gain mode. Two values will be displayed. The "d11" value represents the indirect counts received at Detector 1. The "d10" value on the second line of the display represents the direct counts received at Detector 0.

```
Counts:        d11=725
d10=25727              #=Cont
```

This test is used in troubleshooting sensor problems, and is explained in detail in Chapter 11.

To return to the main setup menu from the test menu, press 0.

5.1.4 Boot

Pressing 4 at the Setup Menu (Boot) gives you the option of restarting the 8365 using either a software reboot or a system reboot.

```
0=Exit      1=SW Reboot
2=System Reboot
```

Pressing 0 will return you to the main setup menu without resetting the sensor.

Pressing 1 will initiate a software reboot, which resets the sensor firmware, but does not affect the sensor hardware.

Pressing 2 will reset the entire system. Power will be reset, and the sensor will restart. If the sensor is running under battery power exclusively, the BATTERY START switch must be depressed to restart battery power.

5.1.5 System Configuration

Sensors are configured at the factory for ideal performance in a particular application. Depending on this configuration, certain of the following screens and prompts may be omitted.

Press 5 at the Setup Menu to initiate system configuration. The first menu will show:

```
Report Type:    0=AWOS
                1=STD
```

Select the report type by pressing the appropriate number key. When AWOS output is selected, the configuration is set automatically and the message "End of Configuration—Saving Data" will be displayed. You will then be returned to the setup menu. If standard output is chosen, the display will then prompt you for the output interval.

```
Output Int:      0=10sec
(min)  1=1   2=5   3=10
```

Select an output interval. The display will advance to the averaging interval menu:

```
Avg Interval:   (min)
0=3    1=5     2=10
```

Select an averaging interval. The display will advance to the output type menu:

```
Output      0=Vis
  Type:     1=Ext Coef
```

Select an output type (visibility or extinction coefficient). The display will advance to the units menu:

```
Units:   0=miles
         1=kilometers
```

Select a units system for displayed data. The display will advance to the baud rate menu:

```
Baud:    0=300    1=1200
2=2400   3=4800   4=9600
```

The value entered here sets the baud rate for the data output serial port (external computer). Select a baud rate for the port. The display will advance to the sensor address menu:

```
SENSOR ADDR. (0 - 9)
Enter 1 digit
```

If multiple visibility sensors are connected to a central computer, this option lets you specify a unique address for each sensor. When a single sensor is used, the address 0 is normally assigned to it.

To assign a sensor address to the sensor, enter any one-digit value between 0 and 9. This will complete the configuration procedure, and the configuration data will be saved automatically. The display will read:

```
End of Configuration
Saving Data
```

Once the data is saved to nonvolatile RAM, the display will return to the setup menu.

To exit from the setup menu and return to the normal display, press 0 at the setup menu.

6. OPERATION

6.1 SWITCHES

6.1.1 Main Power Switch

The main power switch is located on the AC Interface board, a smaller printed circuit board mounted in the lower right corner of the controller enclosure, beneath the Visibility Controller Board (see Figure 29). This switch must be in the ON position when operating from AC power.

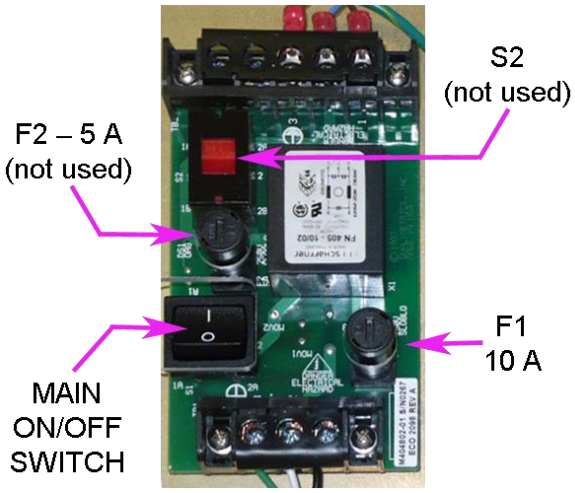


Figure 29. AC Interface Board

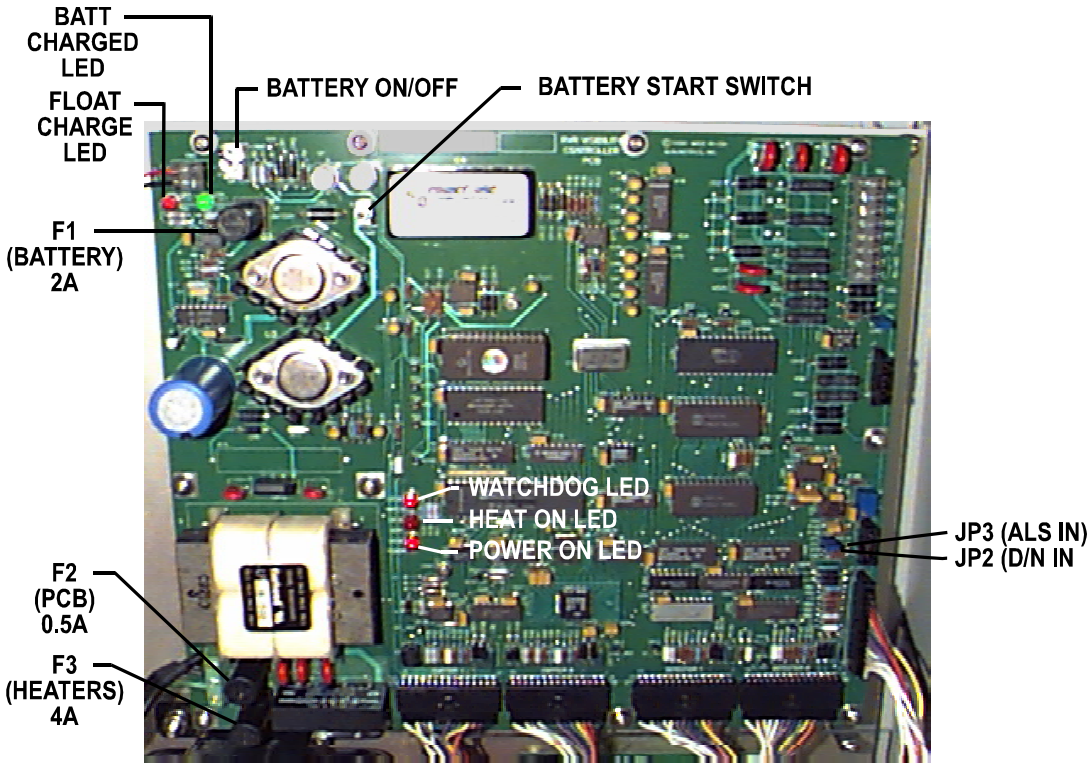
6.1.2 Battery Switch

The Battery ON/OFF switch located in the upper left corner of the Visibility Controller Board (see Figure 30) allows an installed optional backup battery to power the system and to be charged by AC power. This switch must be ON to charge the battery or power the system from battery power. When AC power is removed, however, and the system is not operating from battery power, this switch should be turned OFF to prevent the battery from being depleted.

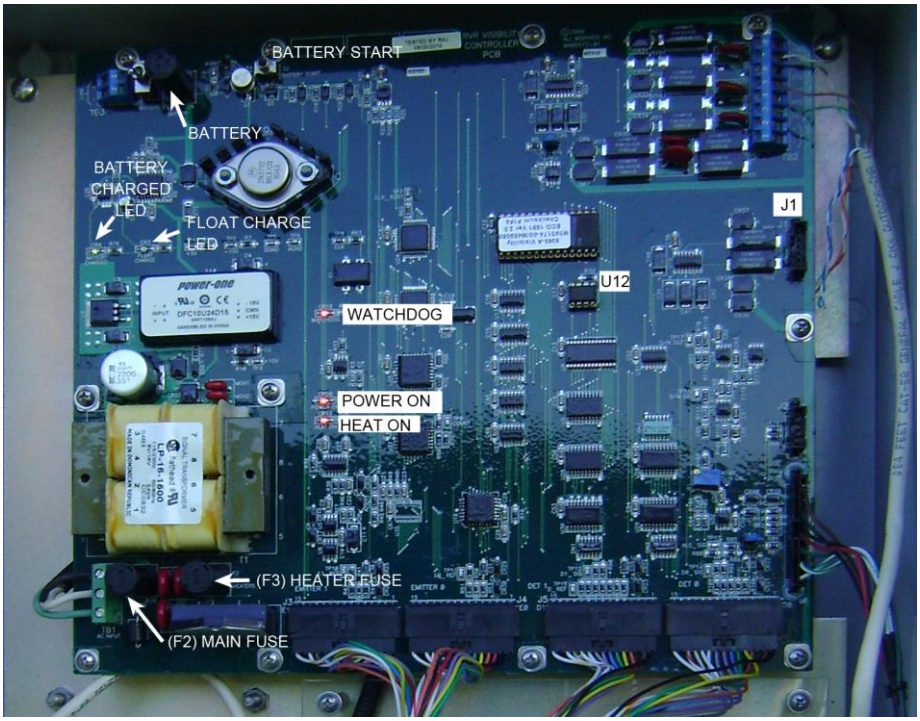
6.1.3 Battery Start Switch

If an optional backup battery is installed, it will automatically become the sensor's power source in the event of a loss of AC power. If, however, the system is powered up on battery power only, the BATTERY START switch must be depressed to initiate battery power.

The BATTERY START switch is located in the upper left of the Visibility Controller Board just to the left of the large, rectangular component U4 (see Figure 30). To initiate battery power, depress the BATTERY START button and hold it down for 3-4 seconds.



8365-A



8365-C

Figure 30. Visibility Controller Board Component Locations

6.2 CONTROLLER BOARD LEDS

A series of LEDs located on the Visibility Controller Board provide a visual indication of sensor operation. Figure 30 shows the location of these LEDs.

6.2.1 Watchdog LED

The red "WATCHDOG" LED should blink on and off during normal operation, indicating that processing is proceeding normally. If the LED does not light at all, or if it stays lighted, an error has occurred.

6.2.2 Heat On LED

The red "HEAT_ON" LED lights when the sensor head heaters are running.

6.2.3 Power On LED

The red "POWER_ON" LED lights whenever AC line power is being supplied to the Visibility Controller Board. This LED will be off when running from battery power.

6.2.4 Battery LEDs

Two LEDs in the upper left of the Visibility Controller Board monitor the charge of the optional backup battery. The green "BATT CHARGED" LED indicates, when lighted, that the battery is charged to operating levels. The red "FLOAT CHARGE" LED indicates, when lighted, that the battery is in the final stages of its charging cycle. When the battery is being charged after being largely depleted, both the "FLOAT CHARGE" and "BATT CHARGED" lights will be off until the charging cycle is nearly complete.

6.3 JUMPERS

Two jumpers on the Visibility Controller Board are used to set the sensor to operate with a Day/Night or ALS sensor. When a Day/Night sensor is installed, JP2 should be installed and JP3 removed (see Figure 30 for jumper locations). When an ALS sensor is installed, JP3 should be installed and JP2 removed. When neither sensor is installed, both jumpers should be removed.

6.4 FUSES

Three fuses are located on the Visibility Controller Board, and two on the AC interface board (see Figure 29 and Figure 30). Though installed, fuse F2 on the AC interface board is not used and should never need to be replaced. The remaining fuses should only be replaced by fuses of the same rating, as shown in the list below.

AC Interface Board

F1 10A 250V, 5×20 mm slow blow

Controller Board

F1 2A 250V, 5×20 mm

F2 0.5A 250V, 5×20 mm

F3 4A 250V, 5×20 mm

6.5 HANDHELD TERMINAL

The Handheld Terminal is used primarily for setup, calibration, and testing of the 8365. However, when the Handheld Terminal is connected but inactive (no key has been pressed over the span of the last output interval) the display will show the time and date, and will alternately display the ALS value (if connected) and the current visibility value. The rate at which the display switches between ALS and visibility data is determined by the output interval (set through the setup procedure). At each output interval, the display will switch to the other data screen (from ALS to visibility, or from visibility to ALS). For example, if the output interval is set to 30 seconds, the ALS data will be displayed for 30 seconds, then the display will switch to visibility data, which will be shown for the next 30 seconds before the display again switches to ALS data.

7. SENSOR OUTPUT

The 8365 Visibility Sensor outputs serial data in both RS-232 and RS-485 formats. The output data packet contains supplementary status and operation information in addition to the visibility data. The user can customize the system's operation for the most useful data output— output interval, averaging interval, output type (visibility or extinction coefficient), and units (miles or kilometers) can all be set through the Setup menu (see Section 5.1).

7.1 OUTPUT DATA FORMAT

Sensor output is available in two formats: Standard format and AWOS format.

7.1.1 Standard Output Data Format

(See Table 3) In standard format, the visibility output data are embedded within a transmission packet that provides for start synchronization and data transmission quality checks. The first part of the packet is the "preface," which consists of three SYNC characters. This allows a simple routine to detect the beginning of a packet, even in noisy conditions.

After the three-character preface comes the actual packet, which includes the sensor model, sensor address, date, time, visibility (reported as visibility in miles or kilometers or as the extinction coefficient), ALS value (in candela/m^2), and Status Words 0, 1, and 2 (see Tables 5, 6, and 7). The final part of the packet provides data on several sensor parameters that can be helpful in troubleshooting errors. These include the heater status, sensor head temperature data, sensor mode counts, and ALS counts. All the characters in the packet are printable ASCII to allow monitoring by a terminal. Items that consist of one byte of information are encoded as two hexadecimal ASCII characters. So, for example, "4C" (capitals are used) represents a regular decimal value of 76. Such items are denoted as an "ASCII byte." Similarly, 16-bit items are encoded as 4-hex digits, called an "ASCII word."

The cyclic redundancy code, CRC16, covers all bytes after the three sync characters, up to but not including the 4 bytes of CRC. Following the packet, but external to it, are a carriage return and a line feed to allow the use of printers or terminals in monitoring the data.

Table 3. Standard Output Data Format

Standard Output Data Format			
Segment	**Length**	**Description**	**Example**
Preface	3 SYN characters	Three sync characters	161616 (h)
Packet header	4 ASCII characters	Sensor Description	8365
blank			
Sensor address	2 characters	Range from 00-99, inclusive	01
blank			
Date	8 characters	dd-mm-yyyy	17-10-2010
blank			
Time	8 characters	hh:mm:ss	07:12:14
blank			

Table 3. Standard Output Data Format

Standard Output Data Format			
Segment	**Length**	**Description**	**Example**
Visibility	7 characters	Visibility (miles or km) or Extinction coefficient ($miles^{-1}$)	1.16 (extinction coefficient) — prefixed with spaces
blank			
ALS value	up to 5 digits	ALS data	00245 — prefixed with zeroes
blank			
Status Word 0	4 digits	see Table 5	0048 (h)
blank			
Status Word 1	4 digits	see Table 6	0000 (h)
blank			
Status Word 2	4 digits	see Table 7	0004 (h)
blank			
Heater Status	up to 5 characters	On or Off Status	H-ON or H-OFF
blank			
Detector 0 Temp	6 characters	Temp in °C	034.14 — prefixed with zeroes
blank			
Detector 1 Temp	6 characters	Temp in °C	031.61 — prefixed with zeroes
blank			
Emitter 0 Temp	6 characters	Temp in °C	031.49
blank			
Emitter 1 Temp	6 characters	Temp in °C	029.63
blank			
ALS Temp	6 characters	Temp in °C	030.80
blank			
Mode 0 indirect	6 characters	counts	000377
blank			
Mode 0 direct	6 characters	counts	027266
blank			
Mode 1 direct	6 characters	counts	028146
blank			
Mode 1 indirect	6 characters	counts	000372
blank			
ALS w/led on	6 characters	counts	000500
blank			
ALS w/led off	6 characters	counts	000010
blank			

Table 3. Standard Output Data Format

Standard Output Data Format			
Segment	**Length**	**Description**	**Example**
CRC	2 bytes	CRC, MSB	"ASCII byte ""XX"""
CRC	2 bytes	CRC, LSB	"ASCII byte ""XX"""
Termination	1–2 bytes	<cr><lf>	

* ""(XX)"" signifies that the number shown is a hexadecimal number

7.1.2 AWOS Output Data Format

(See Table 4) AWOS output is the data format used in AWOS systems between the 8365 and the AWOS Model 1190 DCP. The AWOS format data packet consists of the extinction coefficient as calculated by the 8365, and Status Words 0, 1, and 2 (see Tables 5, 6, and 7).

The AWOS Model 1190 DCP is able to poll the sensor using the following command:

VISI*xx*<cr><lf>
where *xx* is the sensor address
00 is sensor address 0, 11 is sensor address 1, …, up to 99 for sensor address 9

The interface is 4800 bps, 8 data bits, 1 stop bit, no parity.

The cyclic redundancy code, CRC16, covers all bytes up to but not including the 4 bytes of CRC. Following the packet, but external to it, are a carriage return and a line feed to allow the use of printers or terminals in monitoring the data.

Table 4. AWOS Output Data Format

AWOS Output Data Format			
Segment	**Length (bytes)**	**Description**	**Example**
Extinction coefficient	3	extinction coefficient from 8365	1.16
blank			
Status Word 0	4	see Table 5	0048 (h)
blank			
Status Word 1	4	see Table 6	0000 (h)
blank			
Status Word 2	4	see Table 7	0004 (h)
blank			
ALS value	up to 5 digits	ALS data	245
blank			
Packet counter	1	increments with each packet; range is from 0–7, inclusive	3
blank			

Table 4. AWOS Output Data Format

AWOS Output Data Format			
Segment	**Length (bytes)**	**Description**	**Example**
8365 flag	1	1 if 8365; 0 if other model	1
blank			
ending sequence	3	always 0<sp>0<sp>0	0 0 0
CRC	2	CRC, MSB	"ASCII byte ""XX"""
CRC	2	CRC, LSB	"ASCII byte ""XX"""
Termination	1-2	cr-lf	

* ""(XX)"" signifies that the number shown is a hexadecimal number"

7.1.3 Other Poll commands

Two additional poll commands are available. The sensor address is the same as used by the VISI*xx* poll command (Section 7.1.2).

VISB*xx*<cr><lf>

Use VISB*xx* if you need a poll command with a different connection speed set externally. Baud rates up to 4800 bps are supported.

VISD*xx*<cr><lf>

Use VISD*xx* to output a debug data string.

7.2 STATUS WORDS

Three status words are output by the 8365, and can be used for troubleshooting sensor problems. Status Word 0 (Table 5) contains information vital for ensuring data integrity, along with some basic configuration information. Status Word 1 (Table 6) contains status information for the emitter and detector heads and operational modes. Status Word 2 (Table 7) contains ALS and Day/Night sensor status information, along with power supply status.

7.2.1 Decoding Status Words

The status words are expressed as hexadecimal numbers derived from the binary values for each of the individual status bits in the word. Hexadecimal numbers are used because a single hexadecimal character can represent four binary digits (bits). The hexadecimal system includes the numbers 0-9 and the characters A-F, with A-F being used to represent the numbers 10-15 with a single character.

Each hexadecimal character in a status word represents the sum of four binary digits (bits). Binary and hexadecimal numbering proceeds from the right to the left, so the rightmost character represents the binary sum of bits 0-3; the second character from the right represents the sum of bits 4-7; the next character to the left represents the sum of bits 8-11; and the leftmost character represents the sum of bits 12-15.

The following section contains a step-by-step discussion of how to decode an example status word. A worksheet is provided in Table 9, which provides spaces to write in actual status words, with each bit already numbered. This table will simplify status word decoding, and can be copied to provide additional worksheets.

Table 5. Status Word 0

Visibility Sensor Status Word 0			
BIT	**FUNCTION**	**VALUE**	**MEANING**
2-1-0	averaging interval	000 001 010 011	3 minutes 5 minutes 10 minutes 1 minute
5-4-3	output interval	001 010 011 100	10 seconds 1 minute 5 minutes 10 minutes
6	output type	0 1	visibility extinction coefficient
7	units	0 1	miles kilometers
8	configuration error indicator	0 1	OK error
9	visibility data incomplete status	0 1	data complete data incomplete (from at least 1 head)
10	visibility data missing status	0 1	OK data from more than 1 head is missing
11	visibility dirty window status	0 1	OK window dirty
12	three-headed operation indicator	0 1	Four-headed operation (normal) Three-headed operation
13-15	unused		

Table 6. Status Word 1

Visibility Sensor Status Word 1			
BIT	**FUNCTION**	**VALUE**	**MEANING**
0	mode 0, direct	0 1	OK failed
1	mode 0, indirect	0 1	OK failed
2	mode 1, direct	0 1	OK failed
3	mode 1, indirect	0 1	OK failed
4	emitter 0 status	0 1	OK failed
5	emitter 1 status	0 1	OK failed
6	detector 0 status	0 1	OK failed
7	detector 1 status	0 1	OK failed
8	cross-check	0 1	OK failed
9	emitter 0 heater status	0 1	OK failed
10	emitter 1 heater status	0 1	OK failed
11	detector 0 heater status	0 1	OK failed
12	detector 1 heater status	0 1	OK failed
13	ALS or D/N heater status (note: this bit is ignored when neither an ALS nor Day/Night sensor is present)	0 1	OK failed
14-15	reserved		

Table 7. Status Word 2

Visibility Sensor Status Word 2			
BIT	**FUNCTION**	**VALUE**	**MEANING**
0	ALS installed status	0 1	ALS present ALS not installed
1	ALS dirty window status	0 1	OK window dirty
2	D/N sensor installed status	0 1	D/N present D/N not installed
3	Day/Night indicator (note: this bit is only valid if a D/N sensor is present)	0 1	night day
4-7	unused		
8	power source indicator	0 1	on AC power on battery power
9	5V power supply status	0 1	OK failed
10	15 V power supply status	0 1	OK failed
11	-15 V power supply status	0 1	OK failed
12-15	unused		

Example

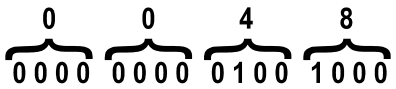
As an example of how to decode a status word, let's use the value 0048. This is a common value for Status Word 0, since it represents a common configuration and operating status for an 8365 functioning normally.

To decode the status word, the first step is to convert the four hexadecimal characters to their binary equivalents. Table 8 shows the binary equivalents for all the possible hexadecimal characters.

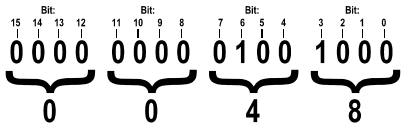
Table 8

Hexadecimal and Binary Equivalents	
Hexadecimal Value	**Binary Value**
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1
A	1 0 1 0
B	1 0 1 1
C	1 1 0 0
D	1 1 0 1
E	1 1 1 0
F	1 1 1 1

Locate the binary equivalent for each hexadecimal character in the table, and write them down. For the example (0048), this would give:



There should be 16 bits in total, with each bit having a value of either 0 or 1. Start with the rightmost bit, assign the next number to each bit, beginning with Bit 0 as shown below.



The bits can then be compared against Table 5 to determine their meanings.

In most cases, each individual bit represents a certain condition based on its value of 0 or 1. The first six bits in Status Word 0 are the only exception to this. These bits are used in combination to convey configuration information (averaging interval and output interval), and so must be looked at as a group rather than as individual bits. To simplify this, Table 5 shows the bit patterns for these two groups of three bits corresponding to a specific averaging or output interval.

Using the same example, the pattern of the first three bits in the status word (again reading right to left) is 0 0 0. Looking at Table 5, this bit pattern for bits 0-2 means that the averaging interval is set to 3 minutes. Looking at the next three bits (bits 3-5), we see the pattern is 0 0 1. Again referring to Table 5, this bit pattern represents an output interval of 10 seconds.

The remaining bits in the status word can then be evaluated individually, by locating a specific bit on the table and reading the meaning of its current value (0 or 1). Status Words 2 and 3 can be translated in the same way, with each bit being matched to its specific operational meaning. By translating all three status words into their individual components, a great deal of information concerning the sensor's operation can be extracted.

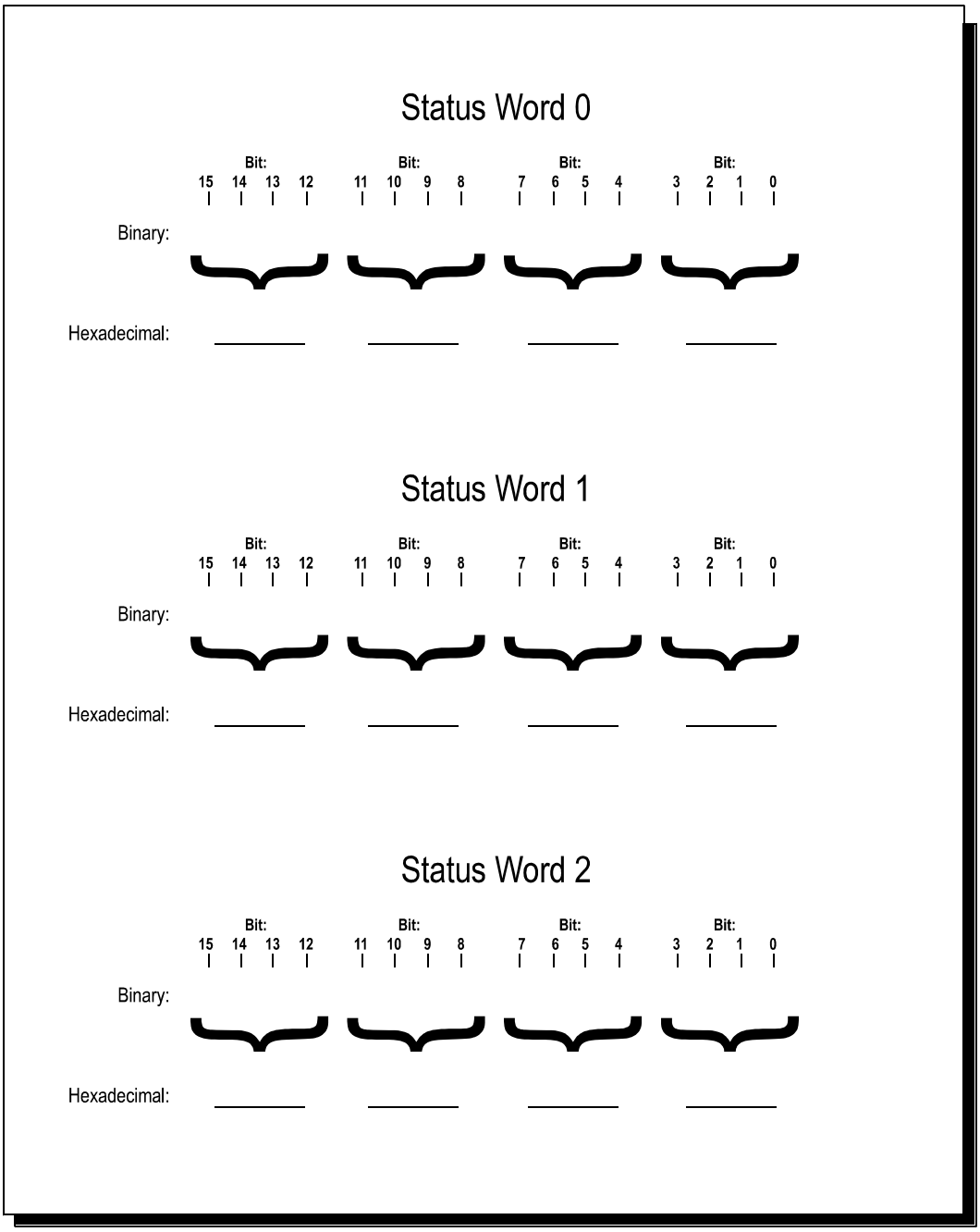


Figure 31. Status Word Worksheet

8. CALIBRATION

8.1 VISIBILITY SENSOR CALIBRATION

The visibility sensor can be calibrated either indoors or outdoors. When calibrating outdoors, there must be at least 7 miles visibility and winds should be calm. The calibration paddle is traceable to Air Force Geophysics Laboratory reference transmissometers. Equivalent extinction coefficient values are printed on each paddle (labeled "**Cal ID #**").

Calibration mode is entered by input from the portable Handheld Terminal, a computer running terminal emulation software (such as Procomm), or the AWOS DCP's keypad/display.

1. With AWOS systems, press the maintenance switch, then press the # key on the DCP keypad repeatedly until the 8365 calibration screen appears.
2. When using the Handheld Terminal, press the ENT key to enter the main menu.

```
0=EXIT   1=D/T      2=CALIB
3=TEST   4=BOOT  5=CFG
```

3. Press "2" to select calibration. The following screen will appear.

```
0=Exit   1=Vis Cal
2=ALS Cal
```

4. Press "1" to select Visibility Sensor calibration. The following screen will appear.

```
Enter Cal. ID:
__
```

5. Enter the **Cal ID #** shown on the calibration paddle's label (see Figure 32), then press ENT. Use the * key to enter a decimal point.

Figure 32. Calibration Paddle Cal ID #

6. You will next be prompted to perform any required maintenance tasks, such as cleaning the sensor windows or removing obstructions in the optical paths. During this time, the sensor will operate alternately in both modes to keep the optical emitters at thermal equilibrium. When the requested tasks are complete, press the # key as prompted.

Clean windows. # = Done

7. The sensor will now begin calibration measurements.

Cal. averaging cycle 01

8. The number on the display will increment as the cycle continues, up to 25. This takes about five minutes. You will then be prompted to insert the calibration paddle.

Insert paddle. # = Done

9. Mount the calibration paddle to the outside of the upright portion of the mount as shown in Figure 33. Secure it by tightening the two thumbscrews at the base. (Note: If the sun is low on the horizon and is reflecting off the calibration paddle into the detectors, loosen the main mounting bolt securing the sensor to the mast and rotate the entire sensor 90°.)

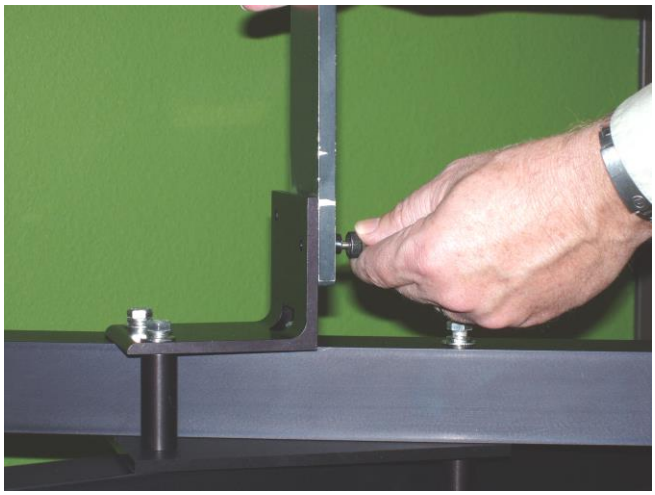


Figure 33. Mount the calibration paddle to the outside of the upright portion of the mount

10. When the calibration paddle is in place, press the # key to continue. The sensor will perform another cycle of calibration measurements.

Cal. averaging cycle 01

11. The number on the display will again increment to 25 as the measurements proceed (again taking about 5 minutes). When the cycle is complete, you will be prompted to remove the calibration paddle.

Remove paddle. # = Done

12. Remove the calibration paddle. If the sensor was rotated during Step 9, rotate it back to its original position. When done, press the # key. You will next be prompted to cover the emitters.

Cover emitters. # = Done

13. The emitters must be covered so that no light from them reaches the detectors. An effective way to do this is to insert a piece of black foam inside the sensor hood, between the emitter window and the arch-shaped brace on the inside of the hood (see Figure 34). Be sure to press the foam all the way up into the hood so that it covers the emitter window completely.

Figure 34. Covering the Emitters

14. When the emitters are blocked, press the # key to continue. The sensor will perform another cycle of calibration measurements.

```
Cal. averaging cycle
01
```

15. The number on the display will again increment to 25 as the measurements proceed (again taking about 5 minutes). When the cycle is complete, you will be prompted to uncover the emitters.

```
Remove covers.
          # = Done
```

16. Remove the foam blocks from the emitters, then press the # key.
17. The sensor will generate a new calibration factor based on the measurements taken. The display will show the old and new values.

```
Cal Fctr:   Old = 54.908
New = 54.738   # = Cont
```

18. Record the old and new calibration factors in an ongoing log for future reference, then press the # key to continue to the next screen.

```
% Change = 0.3
# = Accept  * = Reject
```

19. This screen shows the difference between the "old" calibration factor and the newly calibrated factor, as a percentage. Under normal conditions, the "% change" from the old to the new value should be less than 2%. If the value shown is less than 2%, press the # key to accept the new value. If the difference is greater than 2%, press the * key to reject it, then repeat the calibration procedure.
20. Once the calibration value has been accepted, the Visibility Controller Board will return to normal measurement mode using the newly calculated calibration factor.

8.2 ALS CALIBRATION

When purchased and shipped with an 8365, the optional Ambient Light Sensor (ALS) is factory calibrated and should not need to be recalibrated under normal conditions. The ALS is also equipped with a built-in self-calibration feature that automatically adjusts the sensor to compensate for many factors that can affect performance.

If the ALS is added to an already-installed 8365, it will be delivered calibrated from the factory. An EEPROM containing calibration data for the ALS is included in the package. Install this EEPROM in socket U12 on the Visibility Controller Board (U12 is located in a socket to the left of the header J1 connector near the middle right side of the Visibility Controller Board). If an EEPROM is already installed in U12, remove the existing EEPROM and install the new EEPROM in its place. Perform the visibility calibration procedure described in Chapter 8 to set the correct calibration factor in the EEPROM.

8.3 DAY/NIGHT SENSOR CALIBRATION

The optional Day/Night sensor is calibrated before shipment, and should not need to be recalibrated. The sensor is ruggedly constructed and has proven to be very stable over long periods of service in the field. If the sensor should need to be recalibrated, return it along with the entire Visibility Controller Assembly to All Weather, Inc. for servicing.

9. ALIGNMENT

The 8365 is tested and aligned at the factory prior to shipment. Under normal circumstances, alignment is not needed on receipt. Alignment of the 8365 is an electrical procedure; no mechanical alignment is necessary. Note that ***alignment is not the same as calibration***. Alignment essentially configures the system prior to calibration so that calibration will be possible and accurate. A poorly aligned system will lose its accuracy, and the calibration may be suspect, even though the system is put through calibration successfully. It is therefore important that a new calibration sequence be performed after every alignment. Any calibration performed prior to an alignment is considered invalid.

The following items are required for alignment.

1. Oscilloscope
2. Phillips head screwdriver
3. Slotted screwdriver
4. Potentiometer tuner screwdriver (small slotted screwdriver)
5. Two pieces of foam rubber or similar material used to block the emitters
6. Standard calibration paddle
7. Handheld Terminal

Alignment is a complex procedure. If a local facility is not available capable of performing this procedure, the sensor should be returned to All Weather, Inc. for realignment.

Alignment should be done inside, away from the weather, in a dry, open room. Do not try to align the system in a small area, as reflections from walls will distort the results and yield invalid alignment.

9.1 ALIGNMENT CHECK

The alignment of the sensor heads can be checked using a Handheld Terminal as follows,

1. Place the sensor in Mode 1 using the Handheld Terminal.
2. Note the direct counts for Detector 0. The direct counts are equal to twice the detector frequency, and should be in the range 20000-33400.
3. Place the sensor in Mode 0 using the Handheld Terminal.
4. Note the direct counts for Detector 1. The direct counts are equal to twice the detector frequency, and should be in the range 20000-33400.
5. If the results are within the specified range, the heads are in alignment. If the results are outside the specified range, perform the alignment procedures explained below.

9.2 ALIGNMENT PROCEDURE

9.2.1 Cover Removal

Remove the inner and outer sensor head covers from each sensor head as follows:

1. Remove the single screw from the sensor head outer cover and remove the cover.
2. Remove the two Phillips head screws from the inner cover, then remove the inner cover while feeding the ground wire through the hole in the cover.

The alignment procedures are specific to the 8365-A and 8365-C models.

9.2.2 Model 8365-A

9.2.2.1 Bandpass Filter Adjustment

1. Place the sensor in Mode 1.
2. Attach the calibration paddle (see Figure 33).
3. Place the scope probe at TP1 on the Detector 1 Demodulator PCB (Figure 35).
4. Adjust potentiometer R25 on the Detector 1 Demodulator PCB (see Figure 35) for a rectified sine wave. Figure 36 shows the appropriate pattern.

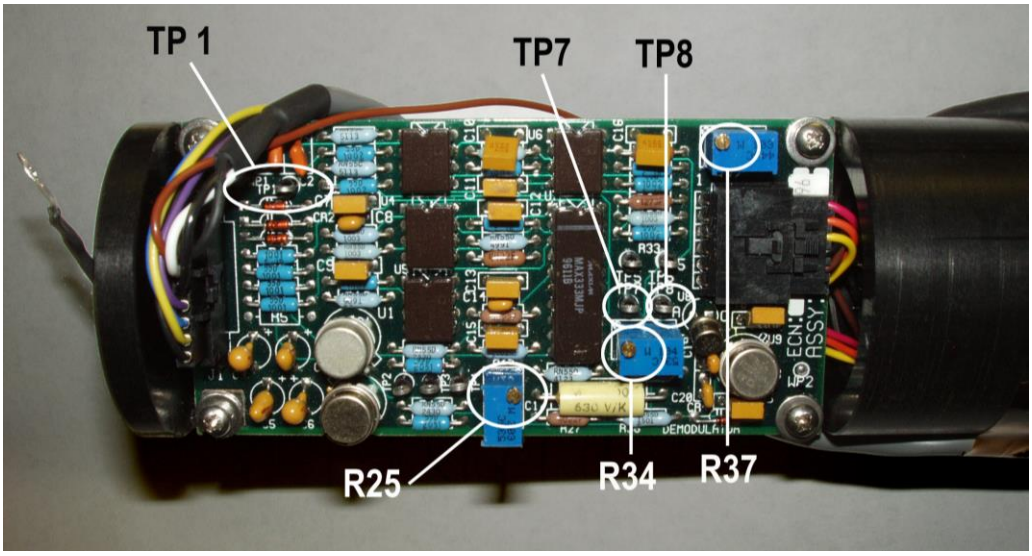


Figure 35. Model 8365-A Detector Demodulator PCB

5. Place the sensor in Mode 0.
6. Place the scope probe at TP1 on the Detector 0 Demodulator PCB (see Figure 35).
7. Adjust potentiometer R25 on the Detector 0 Demodulator PCB (see Figure 35) for a rectified sine wave as done above for Detector 1.
8. Remove the calibration paddle.

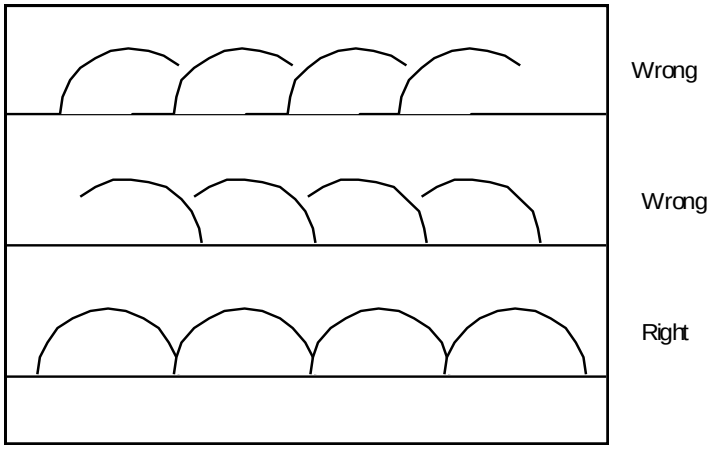


Figure 36. Rectified Sine Wave at TP1 of Demodulator 1 After Adjusting R25

9.2.2.2 Emitter Output Adjustment

1. Place the sensor in Mode 0.
2. Place the scope probe at TP7 on the Detector 1 Demodulator PCB (see Figure 35).
3. Adjust potentiometer R2 on the Emitter 0 PCB (see Figure 37) to obtain a 3.0 V p-p (±0.1 V) sine wave.

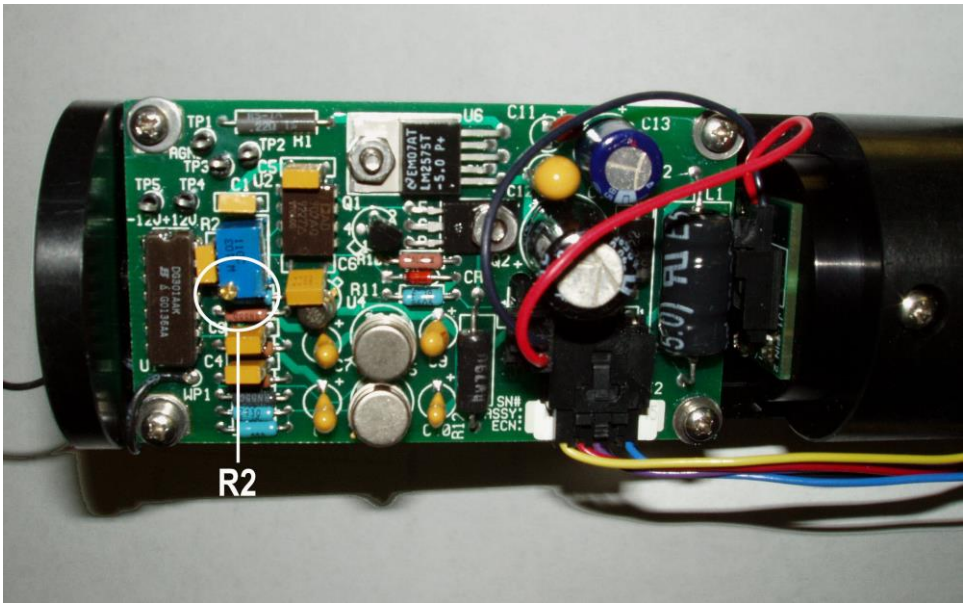


Figure 37. Model 8365-A Emitter PCB

4. Place the sensor in Mode 1.
5. Place the scope probe at TP7 on the Detector 0 Demodulator PCB (see Figure 35).
6. Adjust potentiometer R2 on the Emitter 1 PCB (see Figure 37) to obtain a 3.0 Vp-p (±0.1 V) sine wave.

9.2.2.3 Offset and Gain Adjustments

1. Place the sensor in Mode 0.
2. Place the scope probe at TP8 on the Detector 1 Demodulator PCB (see Figure 35).
3. Completely block the signal into Detector 1 using dense foam rubber or the like.
4. Adjust potentiometer R34 on the Detector 1 Demodulator PCB (see Figure 35) for a 6.0 ±0.2 ms period.
5. Unblock Detector 1 (remove the foam rubber).
6. Adjust potentiometer R37 on the Detector 1 Demodulator PCB (see Figure 35) for a 66 ±1 µs period.

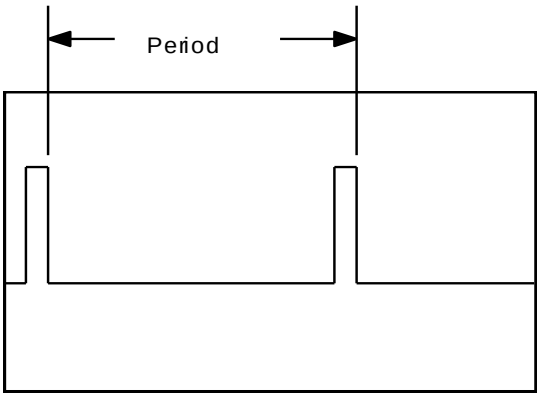


Figure 38. Period of Signal

7. Place the sensor in Mode 1.
8. Place the scope probe at TP8 on the Detector 0 Demodulator PCB (see Figure 35).
9. Completely block the signal into Detector 0 using dense foam rubber or the like.
10. Adjust potentiometer R34 on the Detector 0 Demodulator PCB (see Figure 35) for a 6.0 ±0.2 ms period.
11. Unblock Emitter 1.
12. Adjust potentiometer R37 on the Detector 0 Demodulator PCB (see Figure 35) for a 66 ±1 µs period.

9.2.3 Model 8365-C

9.2.3.1 Bandpass Filter Adjustment

1. Place the sensor in Mode 1.
2. Attach the calibration paddle (see Figure 33).
3. Place the scope probe at TP2 on the Detector 1 Demodulator PCB (Figure 39).
4. Adjust potentiometer R23 on the Detector 1 Demodulator PCB (see Figure 39) for a rectified sine wave. Figure 40 shows the appropriate pattern.

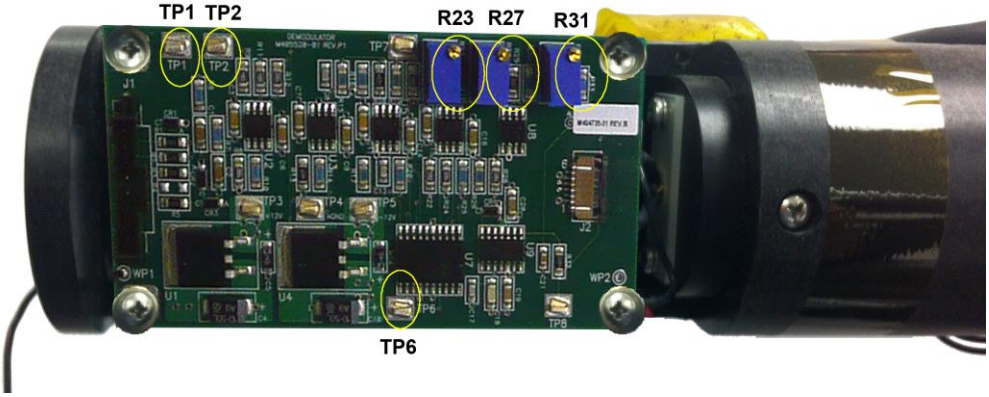


Figure 39. Model 8365-C Detector Demodulator PCB

5. Place the sensor in Mode 0.
6. Place the scope probe at TP2 on the Detector 0 Demodulator PCB (see Figure 39).
7. Adjust potentiometer R23 on the Detector 0 Demodulator PCB (see Figure 39) for a rectified sine wave as done above for Detector 1.
8. Remove the calibration paddle.

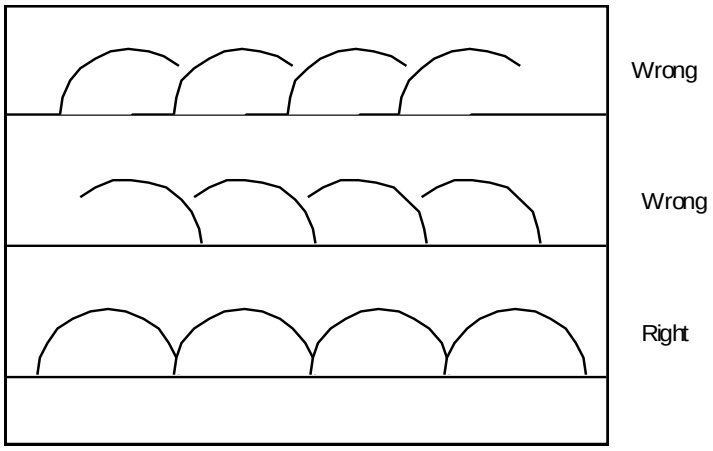


Figure 40. Rectified Sine Wave at TP2 of Demodulator 1 After Adjusting R23

9.2.3.2 Emitter Output Adjustment

1. Place the sensor in Mode 0.
2. Place the scope probe at TP6 on the Detector 1 Demodulator PCB (see Figure 39).
3. Adjust potentiometer R3 on the Emitter 0 PCB (see Figure 41) to obtain a 3.0 V p-p (±0.1 V) sine wave.

Figure 41. Model 8365-C Emitter PCB

4. Place the sensor in Mode 1.
5. Place the scope probe at TP6 on the Detector 0 Demodulator PCB (see Figure 39).
6. Adjust potentiometer R3 on the Emitter 1 PCB (see Figure 41) to obtain a 3.0 Vp-p (±0.1 V) sine wave.

9.2.3.3 Offset and Gain Adjustments

1. Place the sensor in Mode 0.
2. Place the scope probe at TP1 on the Detector 1 Demodulator PCB (see Figure 39).
3. Completely block the signal into Detector 1 using dense foam rubber or the like.
4. Adjust potentiometer R31 on the Detector 1 Demodulator PCB (see Figure 39) for a 6.0 ±0.2 ms period.
5. Unblock Detector 1 (remove the foam rubber).
6. Adjust potentiometer R27 on the Detector 1 Demodulator PCB (see Figure 39) for a 66 ±1 µs period.

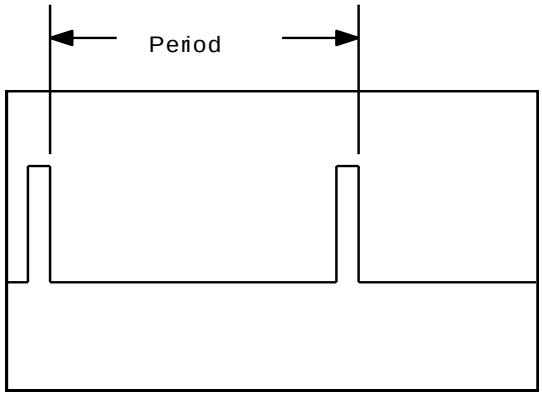


Figure 42. Period of Signal

7. Place the sensor in Mode 1.
8. Place the scope probe at TP1 on the Detector 0 Demodulator PCB (see Figure 39).
9. Completely block the signal into Detector 0 using dense foam rubber or the like.
10. Adjust potentiometer R31 on the Detector 0 Demodulator PCB (see Figure 39) for a 6.0 ±0.2 ms period.
11. Unblock Emitter 1.
12. Adjust potentiometer R27 on the Detector 0 Demodulator PCB (see Figure 39) for a 66 ±1 µs period.

9.2.4 Cover Replacement

Replace the inner and outer sensor head covers on each sensor head as follows.

1. Feed the ground wire through the bottom large hole in the inner cover, and slide the cover into place. (Note that the cover does not slide all the way back to the orange O-ring. There will be a gap between the back of the cover and the O-ring.)
2. Insert one Phillips head screw into the inner cover's lower screw hole and tighten.
3. Insert the second Phillips head screw through the ground wire lug and into the top screw hole, then tighten.
4. Replace the outer covers on all four sensor heads, and secure with one screw in each.

9.3 SENSOR CALIBRATION

The sensor must be put through a calibration procedure after every alignment. It is important that the sensor be calibrated only after it has been mounted in its permanent location. Refer to ***Chapter 8*** for calibration instructions.

10. MAINTENANCE

10.1 NON-AWOS PREVENTIVE MAINTENANCE

The visibility sensor is designed for installation, calibration, and maintenance by one person. For sensors in non-AWOS installations, All Weather Inc. recommends routine sensor maintenance every 120 days, including cleaning and calibration checks.

(Note: Windows may need to be cleaned more frequently, depending on environmental conditions.)

1. Use a soft cloth and a solution of mild detergent in water or a commercial grade window cleaner to clean the emitter and detector windows.
2. As a final rinse, clean the windows with a soft cloth and water only to eliminate any soap streaks.
3. Remove any spider webs or other debris which may block the optical paths.
4. Calibrate the visibility sensor as described in ***Chapter 8***.

10.2 AWOS PERIODIC MAINTENANCE

Periodic maintenance of AWOS sensors is divided into three categories: monthly maintenance, triannual maintenance, and annual maintenance. The listed maintenance routines are performed according to that schedule.

Tools and Equipment Required

- Calibration paddle
- Lens cleaning solution
- Soft cloth

10.2.1 Monthly Maintenance

Clean the visibility sensor windows using a soft cloth and lens cleaning solution.

10.2.2 Triannual Maintenance

Clean the visibility sensor windows using a soft cloth and lens cleaning solution. Calibrate the visibility sensor as described in ***Chapter 8***.

10.2.3 Annual Maintenance

Clean the visibility sensor windows using a soft cloth and lens cleaning solution. Calibrate the visibility sensor as described in ***Chapter 8***. If a Day/Night sensor is installed, check its operation as follows.

1. During daytime, set the DCP's LCD display to show Day/Night status.
2. Verify that the display shows the sensor is reading properly (daytime).
3. Cover the lens with a black bag. Within 3-5 minutes the output should switch to the on (night) state.
4. Uncover the lens, and verify that the output switches back to the off (day) state.

10.3 FUSES

Three fuses are located on the Visibility Controller Board, and two on the AC interface board (see Figure 29 and Figure 30). Though installed, fuse F2 on the AC interface board is not used and should never need to be replaced. The remaining fuses should only be replaced by fuses of the same rating, as shown in the list below.

AC Interface Board

F1 10 A 250 V, 5×20 mm slow blow

Controller Board

F1 2 A 250 V, 5×20 mm

F2 0.5 A 250 V, 5×20 mm

F3 4 A 250 V, 5×20 mm

11. TROUBLESHOOTING

11.1 TROUBLESHOOTING FLOWCHART

A troubleshooting flowchart (Figure 43) is included at the end of this chapter to assist in tracing sensor and controller problems. Use this chart to locate the problem and to determine the necessary tests for isolating the cause and correcting it. The following section describes in detail the troubleshooting tests prescribed in the chart. (*Note: For best results, perform the tests under high-visibility conditions*.)

11.2 FAULT ISOLATION

A fault in the visibility sensor will be manifested in one of three ways.

- The sensor does not complete the visibility cycle
- An erroneous value is reported
- A sensor fault is indicated

Accurate tracing of the indicated problem to its source is necessary for efficient repair of the sensor. To do this, a series of measurements are made under varying conditions and the results recorded on a diagnostic worksheet (Table 9). The data accumulated from these measurements allows the sensor element at fault to be determined.

Table 9. Diagnostic Worksheet

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0						
Mode 0						
Mode 1						
Mode 1						

11.3 TEST MEASUREMENTS

The various tests made in isolating a problem are initiated through the Handheld Terminal, a VT52 terminal or computer running terminal emulation software (such as Procomm), or the AWOS DCP's keypad/display. To set the system up for testing:

1. On non-AWOS systems, connect the Handheld Terminal to the labeled connector on the Visibility Controller Board, or connect a computer or VT52 terminal as explained in ***Setup***. On AWOS systems, press the maintenance switch at the DCP.
2. Press # to call up the main menu.
3. Press "4" to call up the Test menu.

There are two test modes available from the Test menu: Mode 0 and Mode 1. A series of measurements will be taken in each mode under five different sets of circumstances:

- Normal setup, calibration paddle in
- Normal setup, calibration paddle out
- Two emitter cables swapped, two detector cables swapped, calibration paddle in
- Two emitter cables swapped, two detector cables swapped, calibration paddle out
- Sensor head assembly rotated 180°

11.3.1 Mode 0 Test

The first measurement mode used for testing is Mode 0. To enter this mode:

1. Press "1" at the Test menu to begin the Mode 0 test. The display will show:

   MODE 0 Test in
   progress. . .

   In this mode, the emitters and detectors are functioning as follows:

   - Emitter 0 ON
   - Emitter 1 OFF
   - Detector 0 HIGH GAIN mode measuring scattered energy
   - Detector 1 LOW GAIN mode measuring direct energy

2. After the first 15-second measuring cycle, the measured values will be shown on the display. The first set of measurements is always suspect, so use the values displayed following the second 15-second measuring cycle for diagnostics. The values should resemble those shown below.

   Counts: d00=650
   d01=25000 #=Cont

3. Record the values on the worksheet under "Normal, Paddle Out" in the two Mode 0 rows as shown below.

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650				
Mode 0	d01	25000				
Mode 1						
Mode 1						

4. Press the # key. The ALS counts will be shown. Ignore this screen for now. This value is used for advanced troubleshooting of the ALS sensor, and requires specialized equipment. Press the # again at the ALS counts screen to return to the test menu.
5. Insert the calibrator and take a second set of measurements. Again, use the values generated from the second measuring cycle. The values should resemble those shown below.

   Counts: d00=18000
   d01=675 #=Cont
6. Record the values on the worksheet under "Normal, Paddle In."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000			
Mode 0	d01	25000	675			
Mode 1						
Mode 1						

7. Disconnect power from the sensor.
8. Disconnect the two emitter cables from their connectors on the Visibility Controller Board.
9. Connect **Emitter 0** to the **Emitter 1** connector on the Visibility Controller Board, and connect **Emitter 1** to **Emitter 2**'s connector on the Visibility Controller Board.
10. Disconnect the two detector cables from their connectors on the Visibility Controller Board.
11. Connect **Detector 0** to the **Detector 1** connector on the Visibility Controller Board, and connect **Detector 1** to **Detector 2**'s connector on the Visibility Controller Board.
12. Reconnect power to the sensor.

13. Enter test Mode 0 and record the values obtained from the second measuring cycle. The values should resemble those shown below.

    Counts: d00=625
    d01=27000 #=Cont

14. Record the values on the worksheet under "Cables Swapped, Paddle Out."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	**625**		
Mode 0	d01	25000	675	**27000**		
Mode 1						
Mode 1						

15. Insert the calibrator and take a second set of measurements. Again, use the values generated from the second measuring cycle. The values should resemble those shown below.

    Counts: d00=20000
    d01=600 #=Cont

16. Record the values on the worksheet under "Cables Swapped, Paddle In."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	**20000**	
Mode 0	d01	25000	675	27000	**600**	
Mode 1						
Mode 1						

17. Remove power from the sensor and return the sensor cables to their normal positions. Reconnect power to the sensor.

18. Loosen the bolt holding the sensor crossmember to the mast and rotate the sensor head assembly 180°.

19. Enter test Mode 0 and record the values obtained from the second measuring cycle. The values should resemble those shown below.

    Counts: d00=650
    d01=25000 #=Cont

20. Record the values on the worksheet under “Rotated.”

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	20000	650
Mode 0	d01	25000	675	27000	600	25000
Mode 1						
Mode 1						

11.3.2 Mode 1 Test

The next measurement mode used for testing is Mode 1. To enter this mode:

1. Press “2” at the Test menu to begin the Mode 1 test. The display will show:

   MODE 1 Test in
   progress. . .

   In this mode, the emitters and detectors are functioning as follows:

   - Emitter 0 OFF
   - Emitter 1 ON
   - Detector 0 LOW GAIN mode measuring direct energy
   - Detector 1 HIGH GAIN mode measuring scattered energy

2. After the first 15-second measuring cycle, the measured values will be shown on the display. The first set of measurements is always suspect, so use the values displayed following the second 15-second measuring cycle for diagnostics. The values should resemble those shown below.

   Counts: d11=625
   d10=27000 #=Cont

3. Record the values on the worksheet under "Normal, Paddle Out" in the two Mode 1 rows.

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	20000	650
Mode 0	d01	25000	675	27000	600	25000
Mode 1	**d10**	**27000**				
Mode 1	**d11**	**625**				

4. Press the # key. The ALS counts will be shown. Ignore this screen for now. This value is used for advanced troubleshooting of the ALS sensor, and requires specialized equipment. Press the # again at the ALS counts screen to return to the test menu.

5. Insert the calibrator and take a second set of measurements. Again, use the values generated from the second measuring cycle. The values should resemble those shown below.

   Counts: d11=20000
   d10=600 #=Cont

6. Record the values on the worksheet under "Normal, Paddle In."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	20000	650
Mode 0	d01	25000	675	27000	600	25000
Mode 1	d10	27000	**600**			
Mode 1	d11	625	**20000**			

7. Disconnect power from the sensor.
8. Disconnect the two emitter cables from their connectors on the Visibility Controller Board.
9. Connect **Emitter 0** to the **Emitter 1** connector on the Visibility Controller Board, and connect **Emitter 1** to **Emitter 2**'s connector on the Visibility Controller Board.
10. Disconnect the two detector cables from their connectors on the Visibility Controller Board.
11. Connect **Detector 0** to the **Detector 1** connector on the Visibility Controller Board, and connect **Detector 1** to **Detector 2**'s connector on the Visibility Controller Board.
12. Reconnect power to the sensor.
13. Enter test Mode 1 and record the values obtained from the second measuring cycle on the worksheet. The values should resemble those shown below.

    Counts: d11=650
    d10=25000 #=Cont

14. Record the values on the worksheet under "Cables Swapped, Paddle Out."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	20000	650
Mode 0	d01	25000	675	27000	600	25000
Mode 1	d10	27000	600	**25000**		
Mode 1	d11	625	20000	**650**		

15. Insert the calibrator and take a second set of measurements. Again, wait for the second measuring cycle to record the values. The values should resemble those shown below.

    Counts: d11=18000
    d10=675 #=Cont

16. Record the values on the worksheet under "Cables Swapped, Paddle In."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	20000	650
Mode 0	d01	25000	675	27000	600	25000
Mode 1	d10	27000	600	25000	**675**	
Mode 1	d11	625	20000	650	**18000**	

17. Remove power from the sensor and return the sensor cables to their normal positions. Reconnect power to the sensor.
18. Loosen the bolt holding the sensor crossmember to the mast and rotate the sensor head assembly 180°.
19. Enter test Mode 1 and record the values obtained from the second measuring cycle on the worksheet. The values should resemble those shown below.

    Counts: d11=625
    d10=27000 #=Cont

20. Record the values on the worksheet under "Rotated."

VISIBILITY SENSOR DIAGNOSTIC WORKSHEET						
Mode	Detector Mode Identifier	Normal		Cables Swapped		Rotated
		Paddle Out	Paddle In	Paddle Out	Paddle In	
Mode 0	d00	650	18000	625	20000	650
Mode 0	d01	25000	675	27000	600	25000
Mode 1	d10	27000	600	25000	675	**27000**
Mode 1	d11	625	20000	650	18000	**625**

11.4 DATA EVALUATION

The values shown on the display during testing represent counts of the detector output frequency, and will vary with the strength of the received optical signal. The sample values shown in the work-sheets above are idealized values meant to demonstrate the relationships between them when the sensor is operating normally. The actual values may vary fairly widely from these, but their relationships will be unaltered when the sensor is functioning properly. Deviation from the relative values is the main indicator of a problem's source. Under normal conditions, the relationships are as follows.

- With the calibrator out, direct values should be high (20,000 to 33,000), and scatter values should be low (500 to 15,000). The exact values will depend on weather conditions at the time of measurement. In low visibility conditions, scatter values may go very high; inserting the calibrator, however, will still cause them to go higher.

- The calibrator paddle scatters the majority of the emitted energy and greatly reduces the amount of direct energy passing through (simulating very low visibility). With the calibrator in, therefore, the reported values should be the inverse of those described above: direct values will be low, and scatter values will be high.

Swapping the sensor cables causes the sensor to operate as a mirror image of normal, and allows you to determine whether a fault is located in the Visibility Controller Board or one of the heads. The direct emitter-detector signal is the surest indicator of a fault, since a weak or erratic signal may not be as apparent in the scatter values.

If, after swapping the sensor cables, suspicious values appear in the same place (the sensor gives the same reading for the swapped emitter-detector pair as for the original pair) the problem is likely in the controller. If the suspicious values appear on the same emitter-detector pair in their new location, the problem is likely in one of those heads.

To further isolate a sensor head fault, swap the two emitter cables only (connect the **Emitter 0** cable to the **Emitter 1** connector, and **Emitter 1** to the **Emitter 0** connector). If the suspicious value now appears on the same detector, the detector is at fault. If the suspicious value appears on the other detector, the emitter is at fault.

11.5 ALS TROUBLESHOOTING

If an ALS is installed, its operation can be checked by verifying that the ambient light reading drops to near 0 candela in darkness, then returns to normal values in daylight.

1. During daytime, observe the ALS reading on the Handheld Terminal, VT52, or computer running terminal emulation software (connected as described in the Chapter 5). The ALS reading will follow the visibility data on the main display after one output interval has elapsed. (Note: When the sensor is first powered up, a short time is required—about 10 minutes— for the sensor to acquire sufficient data for an average.)
2. Note the ALS reading.
3. Cover the ALS head with a black bag as completely as possible. Observe the ALS reading to see that it drops to near 0 candela.
4. Uncover the head and verify that the ALS output returns to near its original value.
5. If the ALS value does not drop to near 0 candela when covered, or does not return to near its original value when uncovered, contact All Weather Inc. Customer Service.

11.6 DAY/NIGHT SENSOR TROUBLESHOOTING

If a Day/Night sensor is installed, check its operation as follows.

1. During daytime, set the DCP's LCD display to show Day/Night status.
2. Verify that the display shows the sensor is reading properly (daytime).
3. Cover the lens with a black bag. Within 3-5 minutes the output should switch to the on (night) state.
4. Uncover the lens, and verify that the output switches back to the off (day) state.
5. If the sensor does not behave as expected, contact All Weather Inc. Customer Service. If the sensor is to be returned for service, the Visibility Controller Assembly (enclosure and board) must be returned as well.

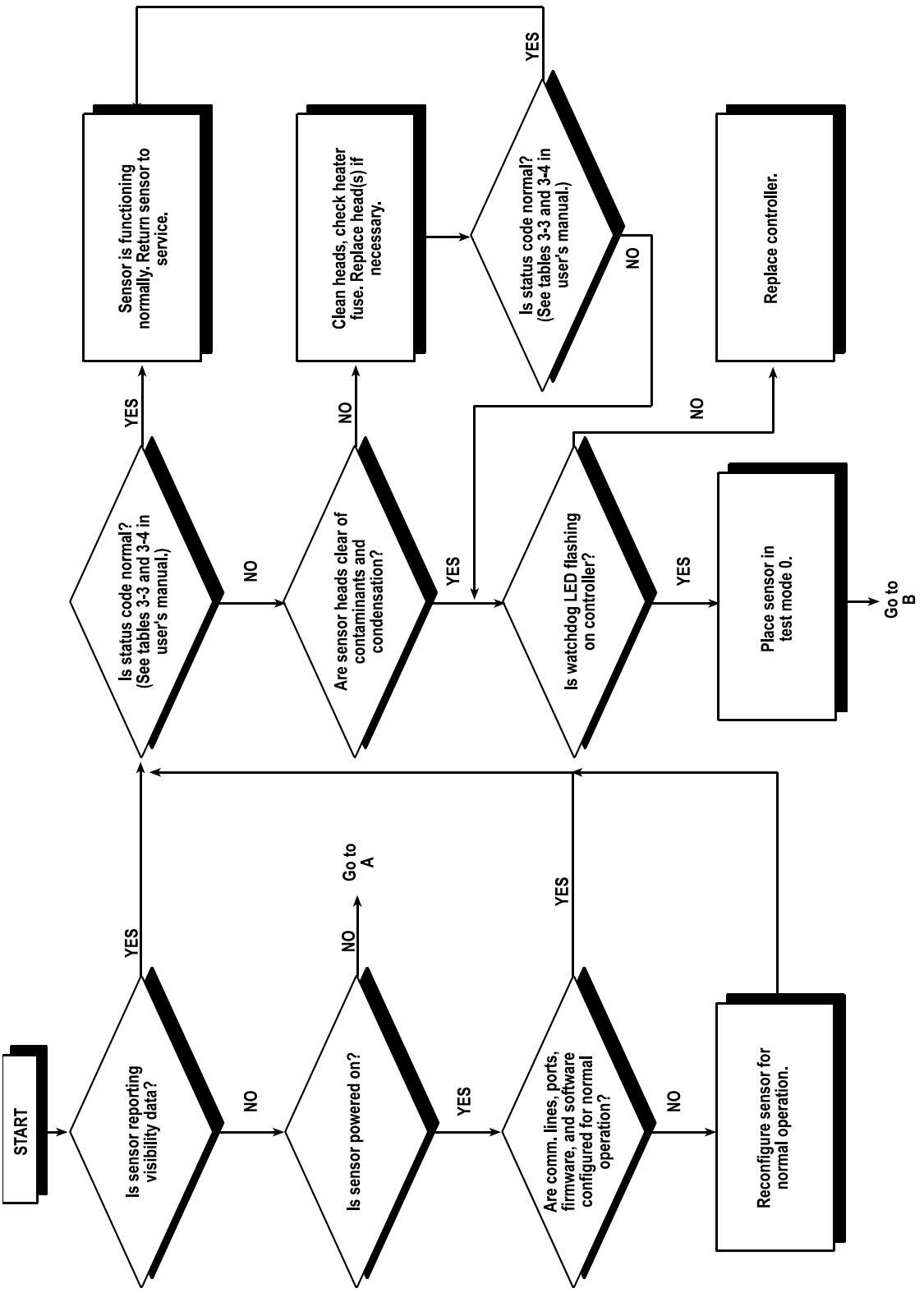


Figure 43. Troubleshooting Flowchart

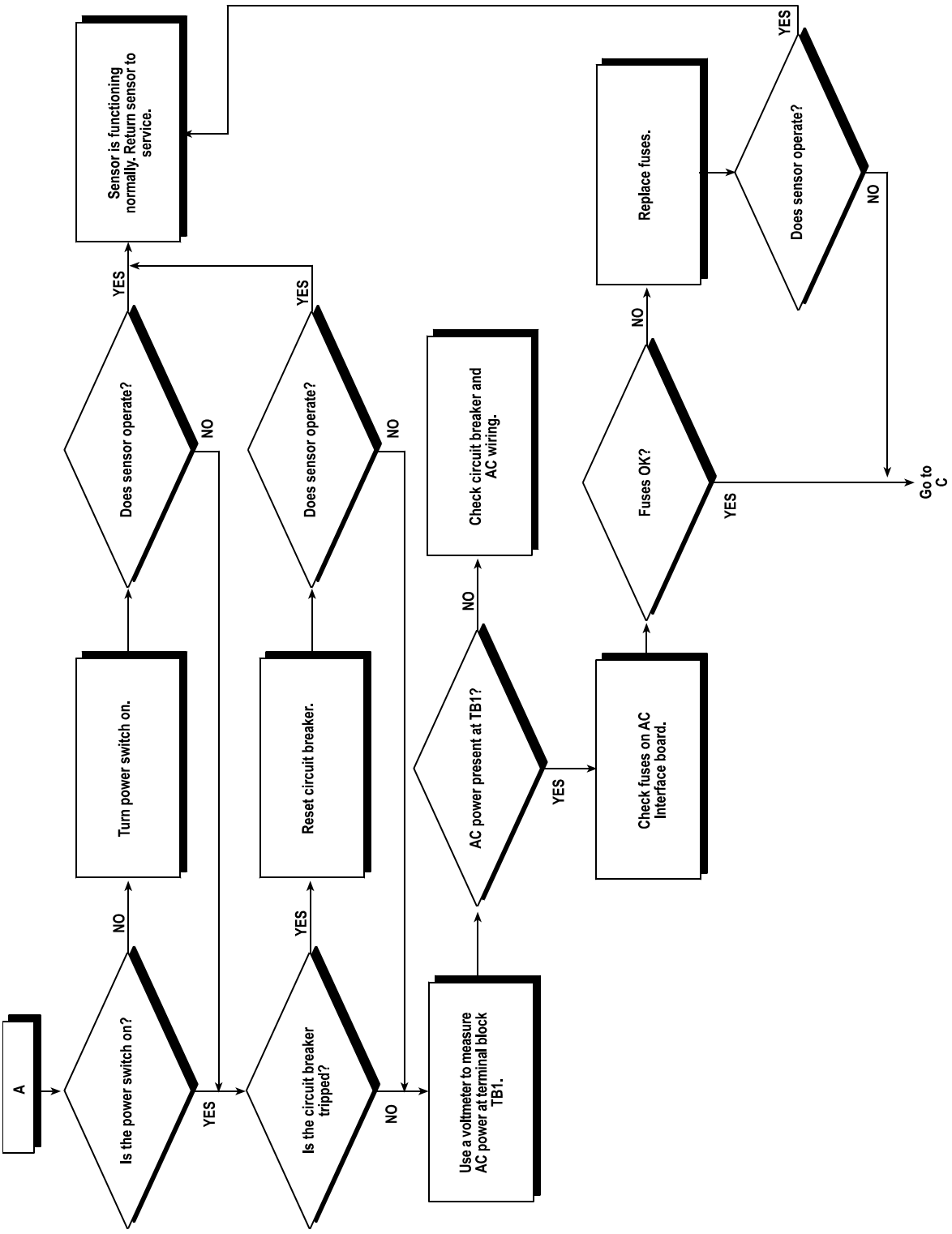


Figure 43. Troubleshooting Flowchart (cont.)

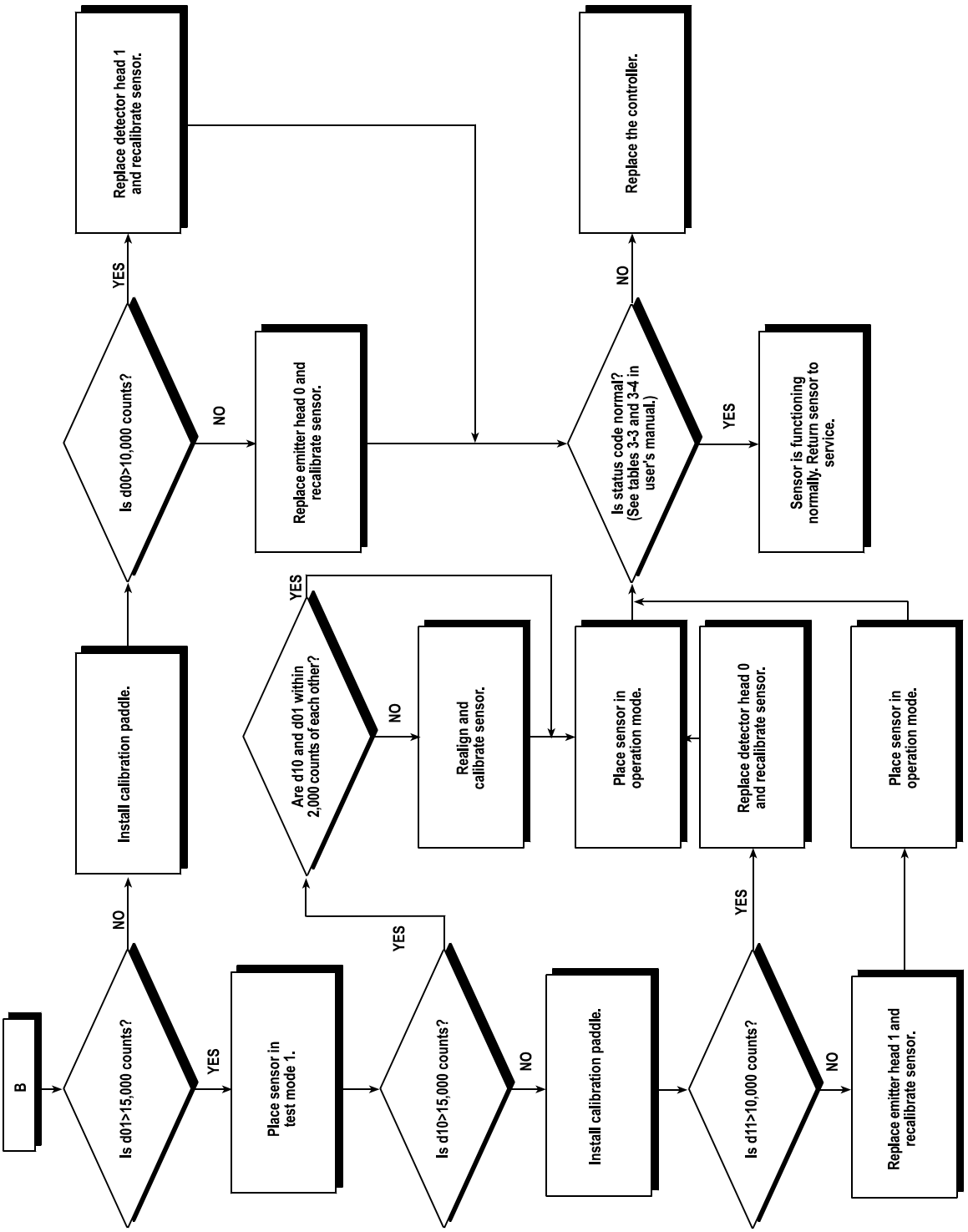


Figure 43. Troubleshooting Flowchart (cont.)

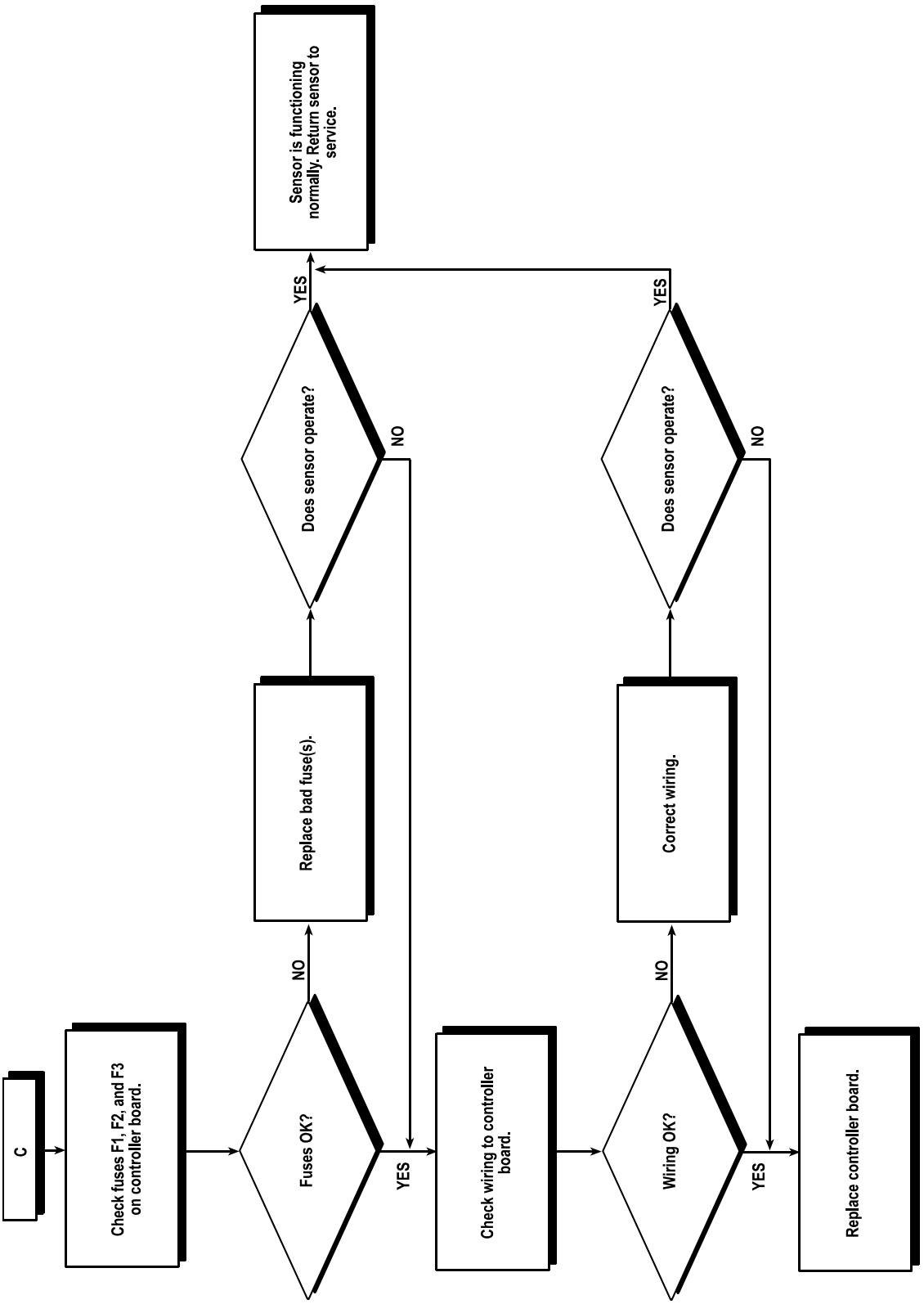


Figure 43. Troubleshooting Flowchart (cont.)

12. OPTIONS AND PARTS LIST

Table 10 shows the lowest replaceable units (LRUs) for the 8365 Visibility Sensor, as well as available options and their part numbers.

Table 10. Options and Parts List

8365 Options and Parts List		
Part Number		**Description**
8365-A	**8365-C**	
M105061-00	M105061-03	Emitter Head
M105060-00	M105060-03	Detector Head
M403322-02	M403322-03	Visibility Controller Assembly
M404811	M404897-00	Visibility Controller Board
M442046		2 A 250 V, 5x20 mm fuse (F1—Visibility Controller Board)
M442057		0.5 A 250 V, 5x20 mm fuse (F2—Visibility Controller Board)
M442048		4 A 250V, 5x20 mm fuse (F3—Visibility Controller Board)
M404802	M404802-01	AC Interface Board
M442071		10 A 250 V, 5x20 mm slow blow fuse (F1—AC Interface Board)
M442070		5 A 250 V, 5x20 mm slow blow fuse (F2—AC Interface Board) NOT USED
M469080-00	M469080-01	Firmware
M104744		Calibration Paddle
Options		
M488171	M488171-01	Ambient Light Sensor Kit
M403326-00		Day/Night Sensor Kit
11903		Battery Backup Kit
M488174		220 V AC Kit
M403321		Handheld Terminal

13. KITS

13.1 AMBIENT LIGHT SENSOR (ALS) KIT

An optional Ambient Light Sensor Kit (M488171-01) is available for the 8365 for use in calculating Runway Visual Range (RVR). The Ambient Light Sensor provides luminance of a six degree field of view of the polar horizon sky at an elevation of 20° to the horizon. The Ambient Light Sensor generates an output frequency signal that is proportional to the actual ambient light level over the range of 0–40,000 cd/m^2. The accuracy of the sensor is 10% of the reading or 0.5 cd/m^2, whichever is greater.

Signal processing is provided by the 8365. A single interface cable between the ALS and the 8365 provides AC heater power, DC power, signal lines, and control lines. This cable plugs into connector J7 on the Visibility Controller Board (M404811).

13.1.1 Calibration

Calibration of the Ambient Light Sensor is performed at the factory prior to shipment. This calibration is referred to as an absolute calibration. To maintain a level of accuracy comparable to this initial absolute calibration (compensate for operation between cleaning of the optical surfaces), a relative calibration is performed automatically and continuously by the sensor itself. The Ambient Light Sensor has proven to be very stable over long periods of service in the field. Because the absolute calibration process requires specialized equipment and procedures, it is recommended that the sensor be returned to All Weather Inc. if recalibration is required.

13.1.2 Specifications

Parameter	Specification
Operating Temperature Range	-40 to +140ºF (-40 to +60ºC)
Storage Temperature Range	-67 to +150ºF (-55 to +65ºC)
Measuring Range	0–40,000 cd/m^2
Accuracy	±10% of reading or 0.5 cd, whichever is greater
Field of View	6°
Mounted Angle Above Horizon	±0.005 inHg (±0.17 hPa)

13.2 DAY/NIGHT SENSOR KIT

A Day/Night Sensor Kit (M403326) is available for the 8365 for adjusting visibility readings for daytime and nighttime conditions. The sensor mounts to the Visibility Controller Assembly enclosure, and is used primarily in AWOS installations, where separate algorithms are used for calculating daytime and nighttime visibility. The Day/Night sensor senses ambient light and reports the existing day or night state. Daytime is reported when the ambient light intensity is above 29 lux (2.7 foot-candles). Nighttime activation occurs when the ambient light intensity falls below 7.5 lux (0.7 foot-candles).

The Day/Night sensor senses ambient light using a photodiode detector, which converts light energy into an electrical current. This current is then converted into a negative voltage representing the light energy in foot-candles. (For example, -2.0 V DC represents 2 foot-candles or 21.5 lux of ambient light.) This voltage is present at TP16 on the Visibility Controller Board.

A comparator circuit is used to provide a switched output from the sensor corresponding to the sensed daytime or nighttime condition. Daytime is represented by an output of 0 V DC, and nighttime by an output of 5 V DC. A certain amount of hysteresis is designed into the comparator circuit to prevent false day/night indications near the sensor's switch-over point. A 10 W heater is built into the sensor to prevent condensation or ice buildup on the photodetector lens.

13.2.1 Specifications

Parameter	Specification
Sensing Element	Photodiode
Night Activation	<7.5 ± 1.6 lux
Day Activation	>29 ± 2 lux
Temperature Range	-40 to +140ºF (-40 to +60ºC)
Output Level—Day	0 V DC
Output Level—Night	5.0 V DC
Size	1.5" × 1.5" × 1.5" (3.8 cm × 3.8 cm × 3.8 cm)

13.2.2 Battery Backup Kit

A 5 A•h Battery Backup Kit (Model 11903) is available for powering the 8365 Visibility Sensor during power outages. The battery connects to the Visibility Sensor via TB3 on the Visibility Controller Board, and can provide up to 3 hours of operation at temperatures above 0°C. The Visibility Controller Board M404811 has a charging circuit that maintains a full charge on the battery when AC power is present.

Switch S1 ("BATTERY ON/OFF") controls the battery voltage to the Visibility Controller Board. This switch must be in the ON position in order for the battery to be charged during AC operation and to provide power to the visibility sensor during a loss of AC power.

In the event of a loss of AC power, the backup battery will automatically become the sensor's power source. If, however, the system is powered up on battery power only, the BATTERY START switch must be depressed to initiate battery power.

The BATTERY START switch is located in the upper left of the Visibility Controller Board just to the left of the large, rectangular component U4. To initiate battery power, depress the BATTERY START button and hold it down for 3–4 seconds.

The backup battery does not power the sensor head heaters, so performance will be somewhat degraded when running from battery power in cold temperatures.

Note: During operation, the "POWER ON" LED should remain illuminated, and the "WATCHDOG" LED should blink at the rate of once per second.

13.3 220 V KIT

The 8365 can operate at 220 V AC with the optional M488174 220 V Kit installed. This option is installed at the factory, and consists of a step-down transformer to convert the incoming 220 V AC to 115 V AC for use by the Visibility Sensor. The Visibility Sensor is then labeled at the factory to indicate an operating voltage of 220 V AC. The transformer is installed inside the Visibility Controller Assembly enclosure.

13.4 HANDHELD TERMINAL KIT

The M403321 Handheld Terminal Kit is used to configure and calibrate the visibility sensor as explained in the ***Setup*** and ***Calibration*** chapters. Though a VT52 terminal or a computer running terminal emulation software can be used, the Handheld Terminal is recommended owing to its ease of use and portability. *(Note: In AWOS systems, the DCP is used to configure and calibrate the sensor, and no Handheld Terminal is required.)*

Instructions for using the Handheld Terminal are provided in the relevant sections of this manual (***Installation, Setup***, ***Alignment***, ***Calibration***, and ***Troubleshooting***).

14. SPECIFICATIONS

Parameter		Specification
Measurement Range	8365-A	33 ft to 20 miles (10 m to 32 km)
	8365-C	33 ft to 50 miles (10 m to 80 km)
Accuracy		±2% measured distance ≤1.35 miles (≤2000 m) ±10% measured distance >1.35 miles (>2000 m)
Resolution	8365-A	330 ft (100 m)
	8365-C	33 ft (10 m)
Measurement Type		MOR or Extinction Coefficient
Averaging Intervals		3, 5, or 10 min
Measurement Units		miles or km
Operating Principle		Dual Technology — direct attenuation and forward-scatter
Light Source		Infrared LED
Optical Bandpass Filter		865 nm ± 35 nm
Detector		Silicon Photodiode
Principal Scatter Detection Angle		35 degrees
Serial Output		RS-485 or RS-232
Output Interval		Programmable: Interrogate, 10 s, 1 min, or 10 min
Output Format		ASCII characters
Baud Rate		Programmable: 300, 1200, 2400, 4800, or 9600 bps
Serial Port Parameter Setting		8-N-1 (8 data bits, no parity, 1 stop bit)
Analog Output Option		
Output Voltage		0–1 V
Output Impedance		100 Ω
Handheld Terminal Port		
Baud Rate		1200 bps
Serial Port Parameter Setting		8-N-1 (8 data bits, no parity, 1 stop bit)
Power Requirements		
Supply Voltage		115 V AC, 60 Hz 240 V AC, 50–60 Hz with M488174 220 V Kit
Max. Current Consumption (ALS installed, heaters on)		1.773 A

Parameter		Specification
Environmental		
Operating Temperature		-40 to +145ºF (-40 to +60ºC)
Storage Temperature		-67 to +145ºF (-55 to +60ºC)
Relative Humidity		5–100%, noncondensing
Wind		up to 120 knots (220 km/h)
Hail		up to 0.5" (1.3 cm) dia.
Ice Buildup		up to 0.5"/h (1.3 cm/h)
Elevation		-100 to 10,000 ft ASL (-30 to 3030 m ASL)
Mechanical		
Controller Assembly Enclosure		NEMA 4X
Mounting	Sensor Assembly	2.5" (6.35 cm) dia. mast
	Controller Assembly	Unistrut mounted
Dimensions	Sensor Assembly	61" L × 19" W × 21" H (155 cm × 48 cm × 53 cm)
	Controller Assembly	14" W × 16" H × 6" D (30 cm × 36 cm × 15 cm)
Weight		74 lbs (33 kg)
Shipping Weight		135 lbs (61 kg)

15. WARRANTY

Unless specified otherwise, All Weather Inc. (the Company) warrants its products to be free from defects in material and workmanship under normal use and service for one year from date of installation or a maximum of two years from date of shipment, subject to the following conditions:

(a) The obligation of the Company under this warranty is limited to repairing or replacing items or parts which have been returned to the Company and which upon examination are disclosed, to the Company's satisfaction, to have been defective in material or workmanship at time of manufacture.

(b) The claimant shall pay the cost of shipping any part or instrument to the Company. If the Company determines the part to be defective in material or workmanship, the Company shall prepay the cost of shipping the repaired instrument to the claimant. Under no circumstances will the Company reimburse claimant for cost incurred in removing and/or reinstalling replacement parts.

(c) This warranty shall not apply to any Company products which have been subjected to misuse, negligence or accident.

(d) This warranty and the Company's obligation thereunder is in lieu of all other warranties, express or implied, including warranties of merchantability and fitness for a particular purpose, consequential damages and all other obligations or liabilities.

No other person or organization is authorized to give any other warranty or to assume any additional obligation on the Company's behalf, unless made in writing and signed by an authorized officer of the Company.

15.1 AWOS WARRANTY

This equipment has been manufactured and will perform in accordance with requirements of FAA Advisory Circular 150/5220-16B. Any defect in design, materials, or workmanship which may occur during proper and normal use during a period of 1 year from date of installation or a maximum of 2 years from shipment will be corrected by repair or replacement by All Weather, Inc.

allweatherinc
All Weather Inc.
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